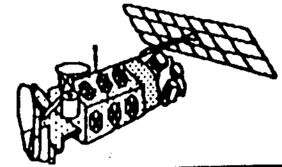


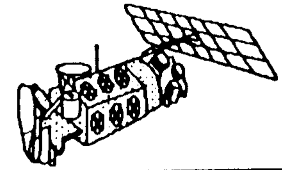
OLS REAL-TIME SMOOTH DATA TRANSMISSION TO SMALL TACTICAL TERMINALS

PROGRESS BRIEFING #1, #2, + #3

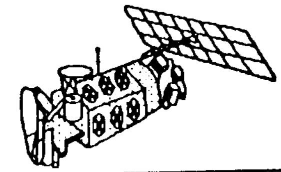
26 July 1989

D.12 632

AGENDA

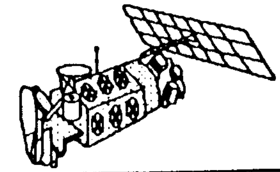


• Real-Time Smooth Data Task Overview	GE
• Meeting Objectives	GE
• WRAASE Receiver Configuration and Operation	HARRIS
• Comparison of OLS Real-Time Smooth Data Format and TIROS APT Data Format	WEC
• Requirements of Real-Time Smooth Data Downlink	GE



AGENDA (CON'T)

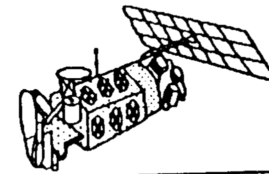
• S-Band Digital Approaches for DMSP	GE/HARRIS/WEC
• VHF/UHF Digital Approaches for DMSP	GE/HARRIS/WEC
• APT Approaches for DMSP	GE/HARRIS/WEC
• Tradeoffs	GE/HARRIS/WEC
• Recommendations	GE/HARRIS/WEC
• Goals/Objectives for Briefing # 2	GE



REAL-TIME SMOOTH DATA

TASK OVERVIEW

TASK OVERVIEW

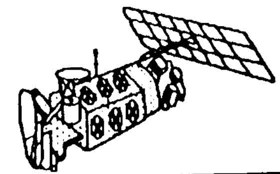


- Space Systems Division has issued task assignments to WEC, Harris, and GE to study methods for providing a new tactical data link for DMSP, receivable by small terminals

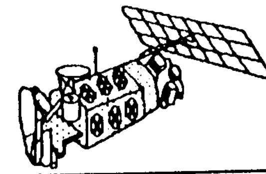
- The three co-contractors are cooperating on a study to investigate and recommend modifications to the current DMSP system to provide a link compatible with the Wraase receiver system or alternative candidate receivers

- Ultimate goal is widespread deployment of DMSP-compatible small tactical receivers (all Army field units, all Navy ships, and all Air Force bases)

TASK OVERVIEW (CONT'D)

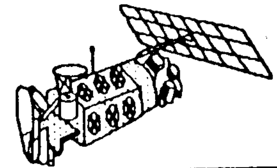


- SSD wants short-term (in 2-3 years) demonstration on a 5D-2 satellite; operational system is goal for 5D-3 (S15-S20)
- Products of study will be:
  - Report describing:
    - Recommended configuration for short-term demo system for 5D-2
    - Recommended configuration for an operational system for 5D-3
  - Functional specification for an operational system for 5D-3, upon USAF acceptance of approach selected
- Report will include trade-off analyses, required hardware/software modifications (satellite and ground) for selected configuration, and ROM cost and schedule estimate

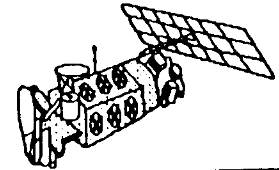


MEETING OBJECTIVES

MEETING OBJECTIVES



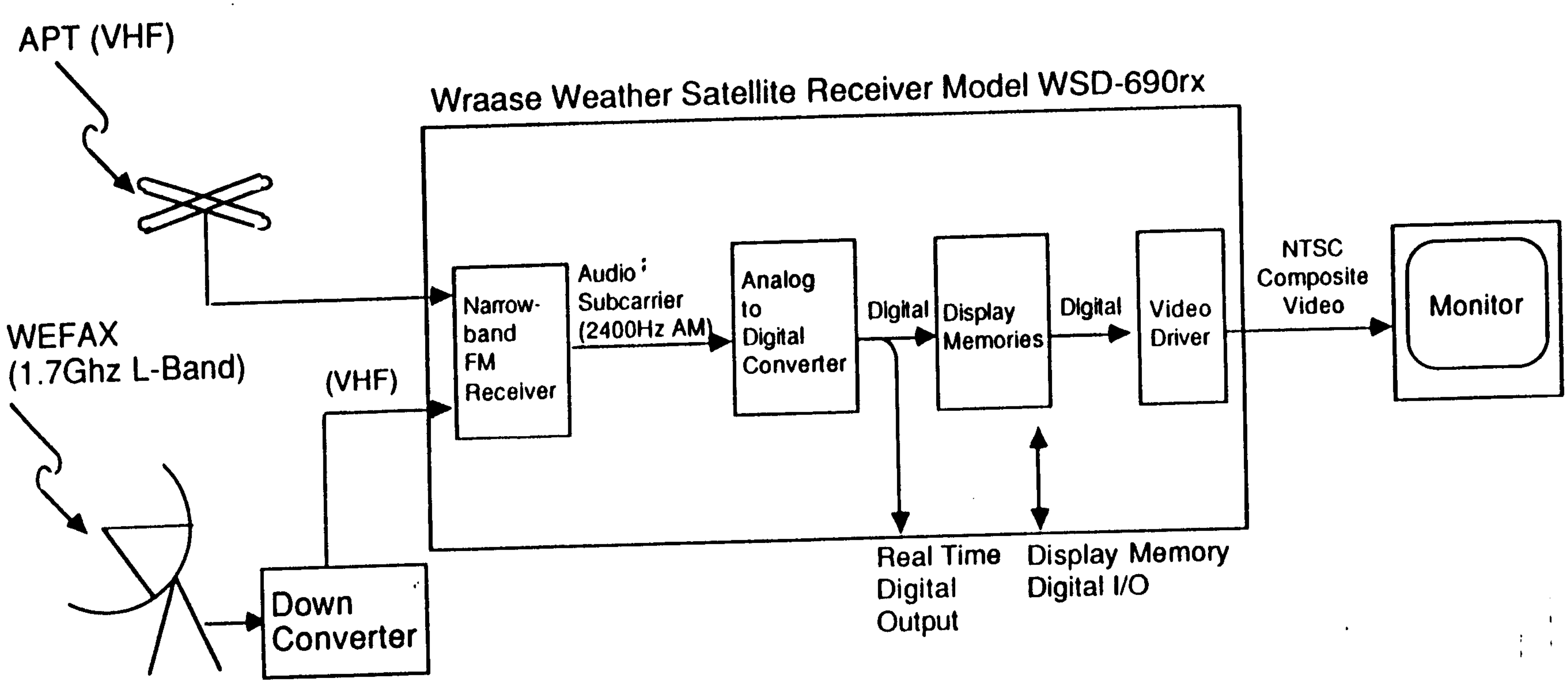
- Present design concepts for a short-term demonstration system on a 5D-2 satellite
- Present design concepts for a long-term fieldable system for 5D-3 satellites
- Present design tradeoffs considered during first phase of the study
- Provide initial recommendations for optimum implementation of demonstration and fieldable systems



WRAASE RECEIVER CONFIGURATION AND OPERATION

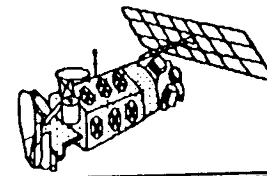
HARRIS
GOVERNMENT INFORMATION
SYSTEMS DIVISION

WRAASE RECEIVER ARCHITECTURE



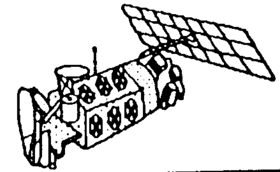
WRAASE RECEIVER CAPABILITIES

- RECEIVES ANALOG SIGNALS FROM METEOROLOGICAL SATELLITES:
  - WEFAX FROM GOES, GMS, AND METEOSAT
  - APT FROM NOAA AND METEOSAT
- STORES UP TO 10 IMAGES AT 512 X 512 X 6 RESOLUTION
  - EXPANDABLE TO 18 IMAGES.
- IMAGE ANIMATION FOR UP TO EIGHT IMAGES
  - EXPANDABLE TO TWO EIGHT-IMAGE LOOPS
- SIXTEEN PRE-DEFINED IMAGE ENHANCEMENTS



COMPARISON OF OLS REAL-TIME SMOOTH DATA FORMAT AND TIROS APT DATA FORMAT

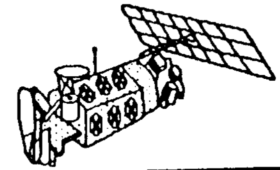
Comparison of APT vs RTSD

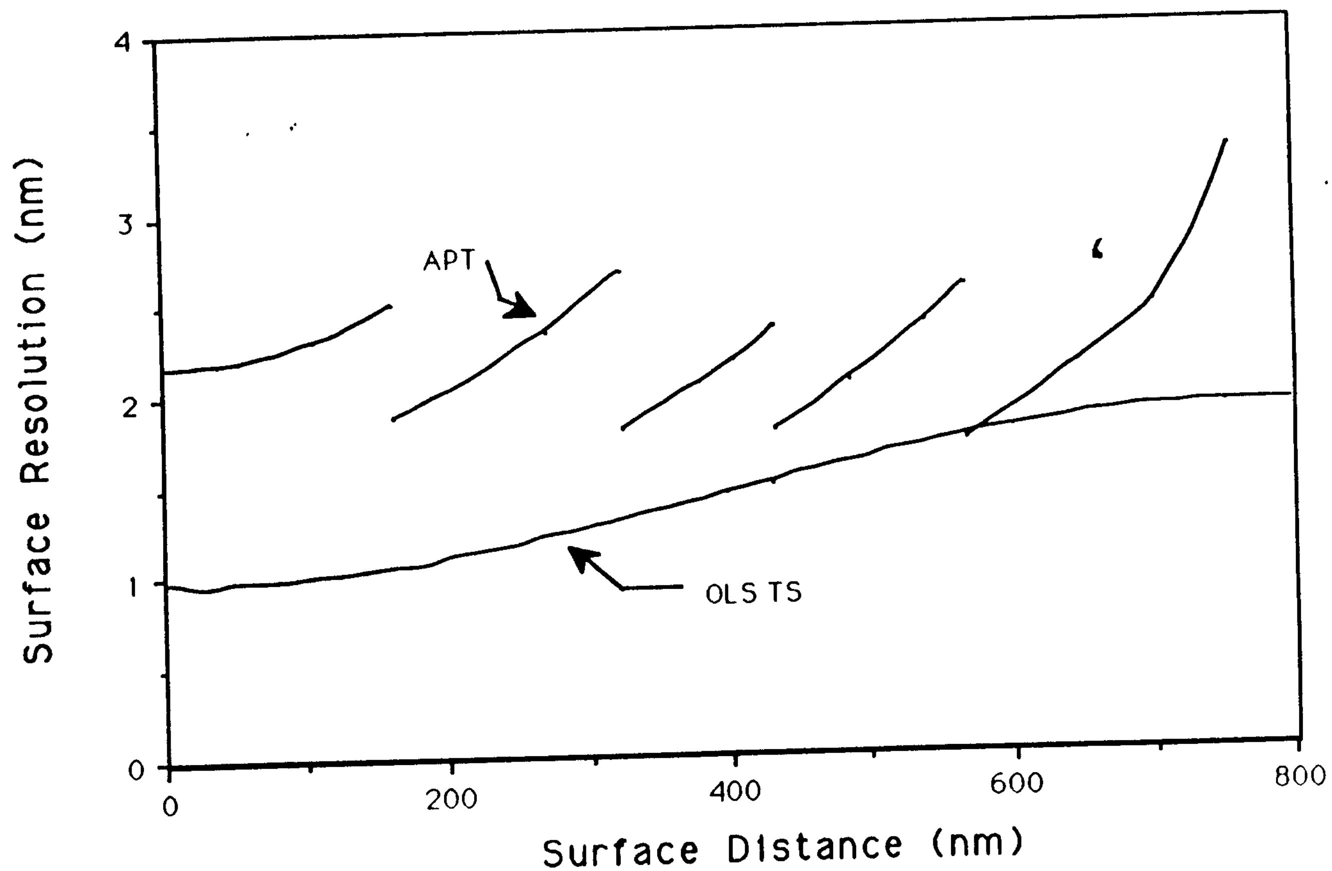


- RTSD is replica of OLS SDS data stream in the record direction providing:
  - 8-bits of Thermal Data
  - 6-bits of Visual (Day or Night) Data
  - L and T video samples are at a nominal 1.5 nm resolution across scan (1460 samples)
  - Cal and Location Data
  - Mission Sensor Data

- APT is a smoothed analog representation of HRPT data from the AVHRR sensor providing:
  - Choice of 2 spectral bands
  - Analog equivalent of 909 8-bit samples per channel per line
  - Samples corrected by an averaging algorithm to provide near constant 4 Km resolution across scan

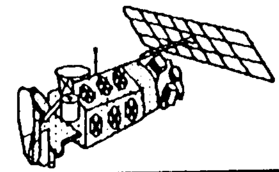
OLS TS vs APT

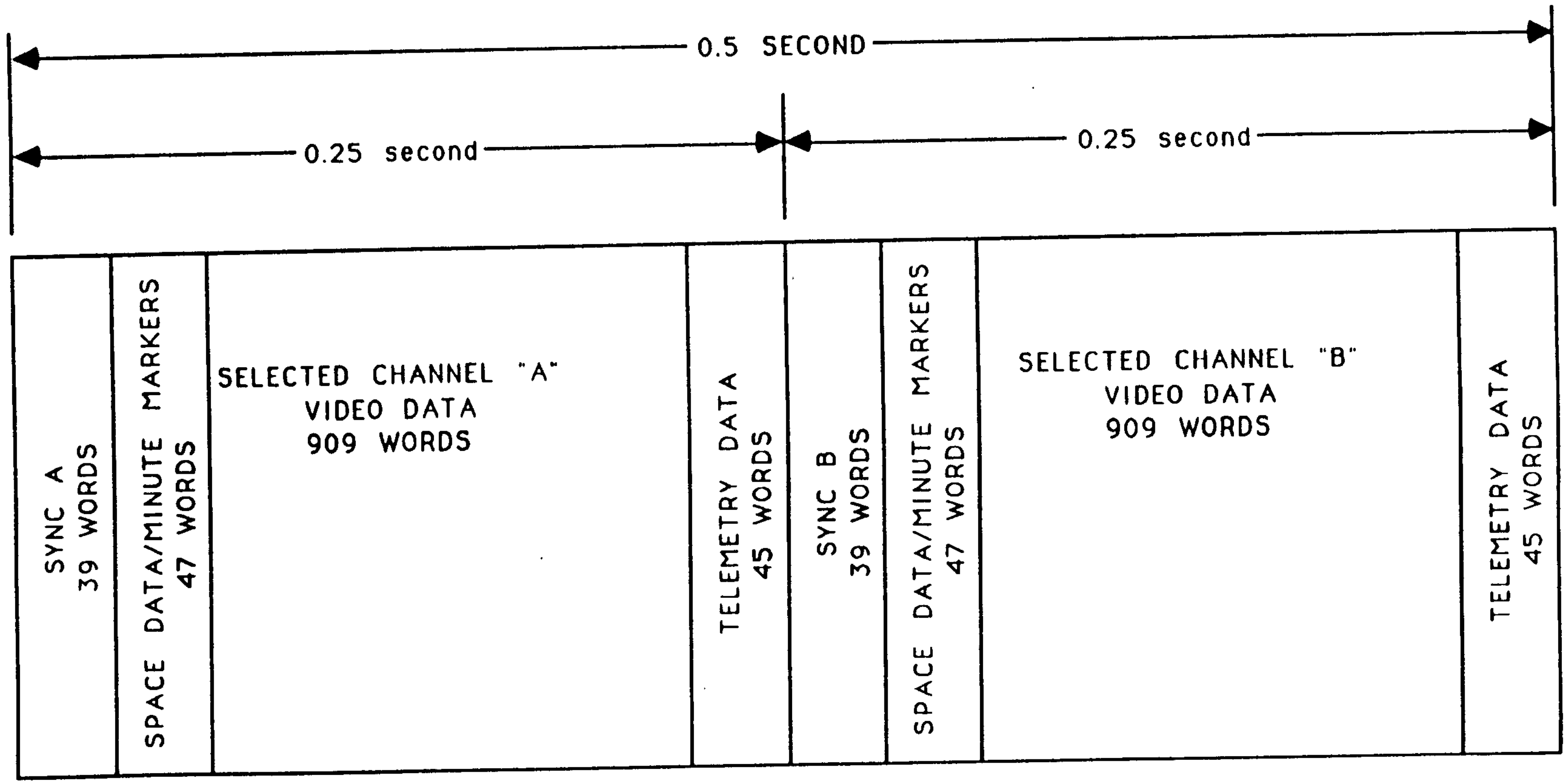




APT
OLS TS
Surface Resolution (nm)
Surface Distance (nm)
0
1
2
3
4
0
200
400
600
800

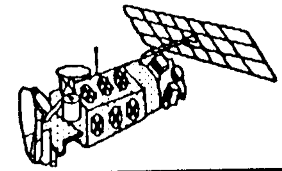
APT Line Format





EQUIVALENT DIGITAL OUTPUT DATA RATE IS 4160 WORDS/SEC
ANY TWO OF FIVE AVHRR CHANNELS MAY BE SELECTED
SYNC A IS A 1040 HZ SQUARE WAVE - 7 CYCLES
SYNC B IS A 832 PPS PULSE TRAIN - 7 PULSES

SDS LINE FORMAT



← RECORD

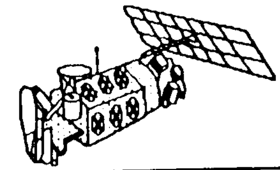
PLAYBACK →

(59)							(1)	(2)	(3)	(4)
F/S	F/S	F/S	F/S	F/S	F/S	F/S	F/S	F/S	F/S	F/S
SSP	SSP	SSP	SSP	SSP	SSP	SSP	SSP	SSP	SSP	SSP
VIDEO	2,3 OR 4 BLANK FRAMES	SUB SYNC OFFSET TIME GAIN CAL TEL/SSP	SSP(T) OR TEL (L)	SSP(T) OR TEL (L)	SSP(T) OR TEL (L)	SSP(T) OR TEL (L)	SSP(T) OR TEL (L) ALARM CODE OFFSET	SSP	SSP VIDEO	VIDEO

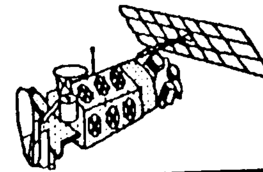
ACTIVE VIDEO ▶|◀ OVERSCAN TIME MIN 277 SAMPLES/MAX 329 SAMPLES ▶|◀ ACTIVE VIDEO 1465 SAMPLES

One SDS line = 420.8 ms

SSM/I DATA PARAMETERS

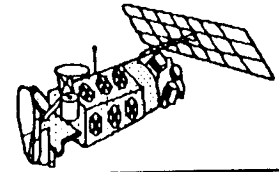


- PRECIPITATION OVER LAND AREAS
- PRECIPITATION OVER WATER
- OCEAN SURFACE WIND SPEED
- ICE AGE AND EDGE LOCATION
- SOIL MOISTURE
- CLOUD AND LIQUID WATER DIFFERENTIATION

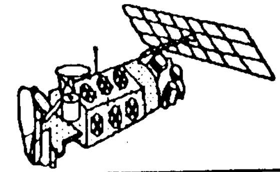


REQUIREMENTS OF REAL-TIME SMOOTH DATA DOWNLINK

REQUIREMENTS OF RTSD DOWNLINK

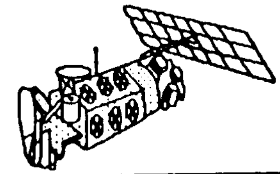


- Use of one of three downlink schemes:
  - S-Band digital
  - VHF/UHF digital
  - VHF analog (APT - equivalent)
- Wraase (or alternative) small tactical receiver compatibility
- Use of existing OLS 66.56 Kbps pre-record RDS data (88.746 Kbps for S16-S20)
- Encryption (dynamic re-keying highly desirable) for long-term operational system
- Simple scheme to grid (earth-locate) data



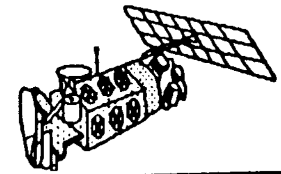
S-BAND DIGITAL APPROACHES FOR DMSP

S-BAND/SPACECRAFT



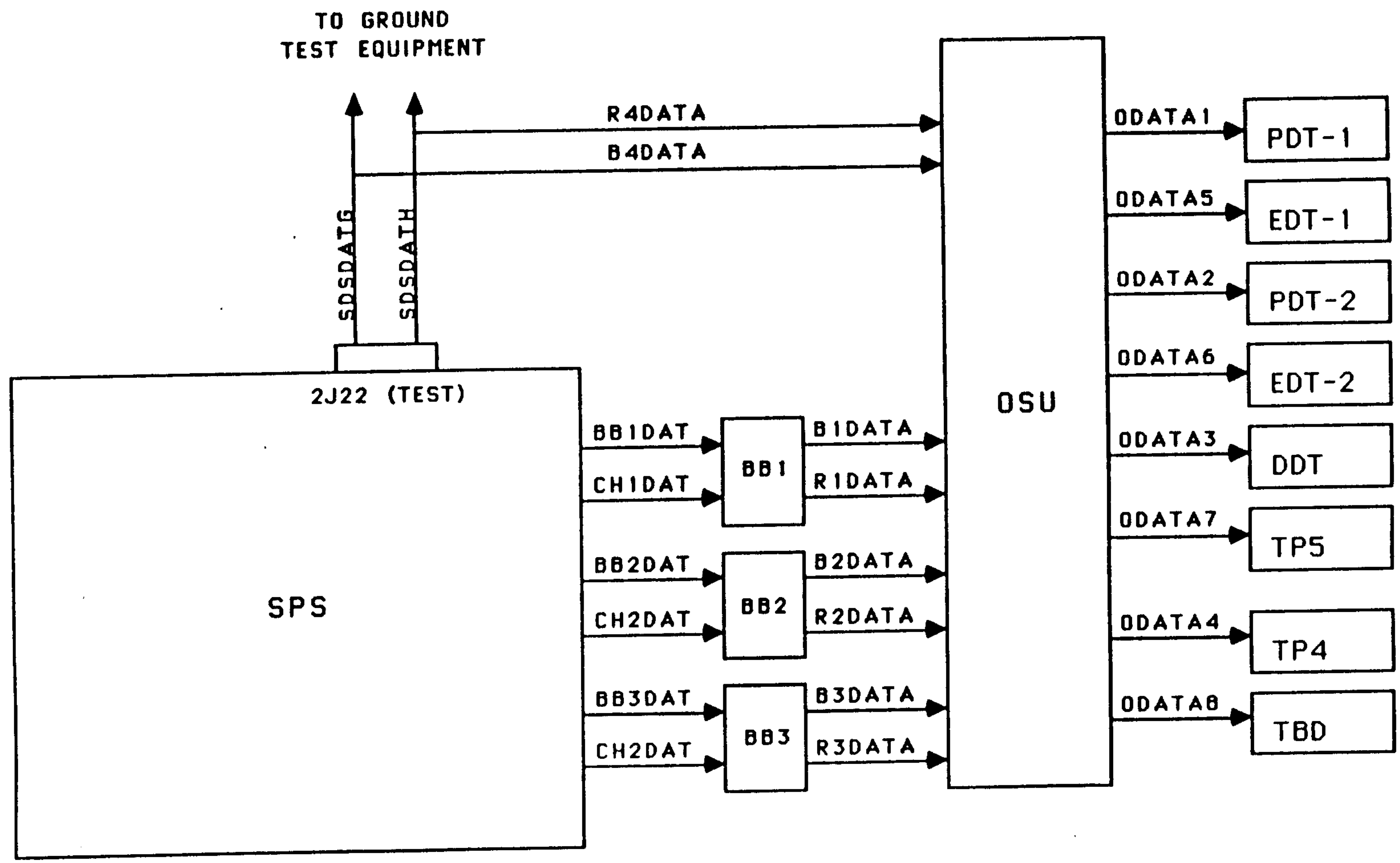
- Three S-Band digital approaches for RDS data transmission:
  - Route RDS data directly to OSU. Use any existing transmitter to transmit data
  - Route RDS data directly to DMU for subcarrier modulation Use EDT-1 or EDT-2 to transmit data
  - Route RDS data through OSU. Use a new S-Band transmitter (with capability of use of one of the existing S-Band transmitters as a backup) to transmit data

S-BAND/SPACECRAFT APPROACH #1

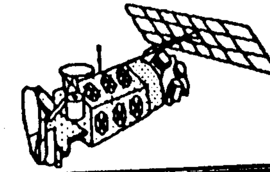


- Port pre-record data, via Channel 4, to either PDT or the DDT bypassing the Output Data Mux and encryptors
- Utilize SPS test connector to route SDS pre-record to the OSU
- Directly modulate any S-Band transmitter with the pre-record data stream
- Advantage: Easiest approach for retrofit into existing systems; no new frequency allocation is required
- Disadvantage: Carrier frequency not receivable by WRAASE; frequency downconversion is required
- Candidate for short-term approach

S-BAND/SPACECRAFT APPROACH #1



S-BAND/SPACECRAFT APPROACH # 2



- Process OLS pre-record data like spacecraft Equipment Status Telemetry data

- Data rates similar: 60 Kbps for spacecraft boost or orbit EST vs. 66.56 Kbps (or 88.75 kbps) for OLS pre-record

- Data formats identical: NRZ-L plus RZ clock

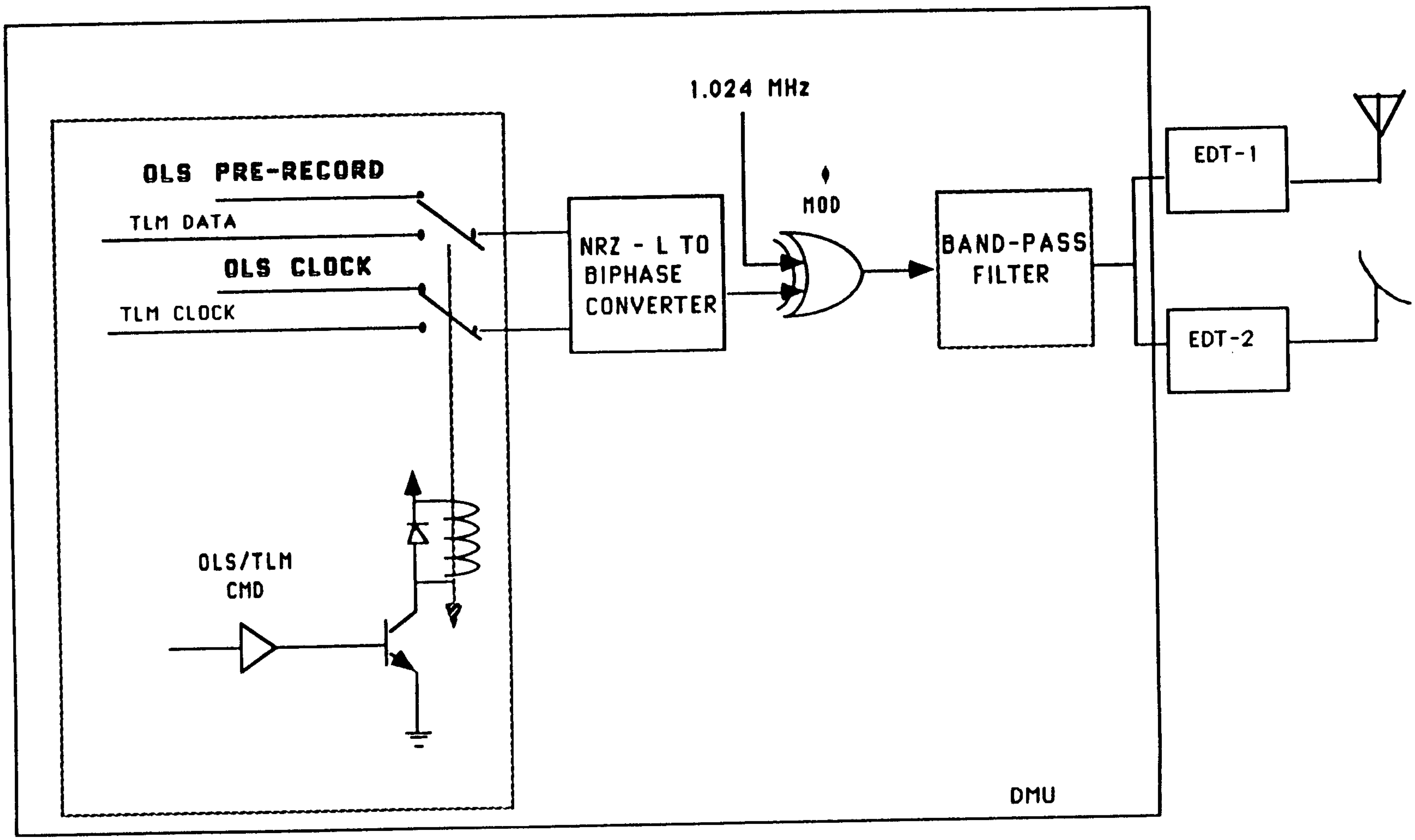
- Requires modifications to spacecraft Dual Modulator Unit

- Advantage: link already proven; high confidence of success; no new frequency allocation is required

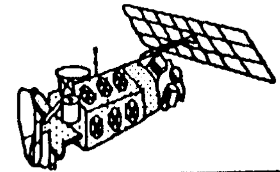
- Disadvantages: *precludes simultaneous downlink of OLS pre-record data and telemetry data* ; carrier frequency not presently receivable by WRAASE receiver; frequency downconversion required

- Candidate for short-term approach

S-BAND/SPACECRAFT APPROACH # 2

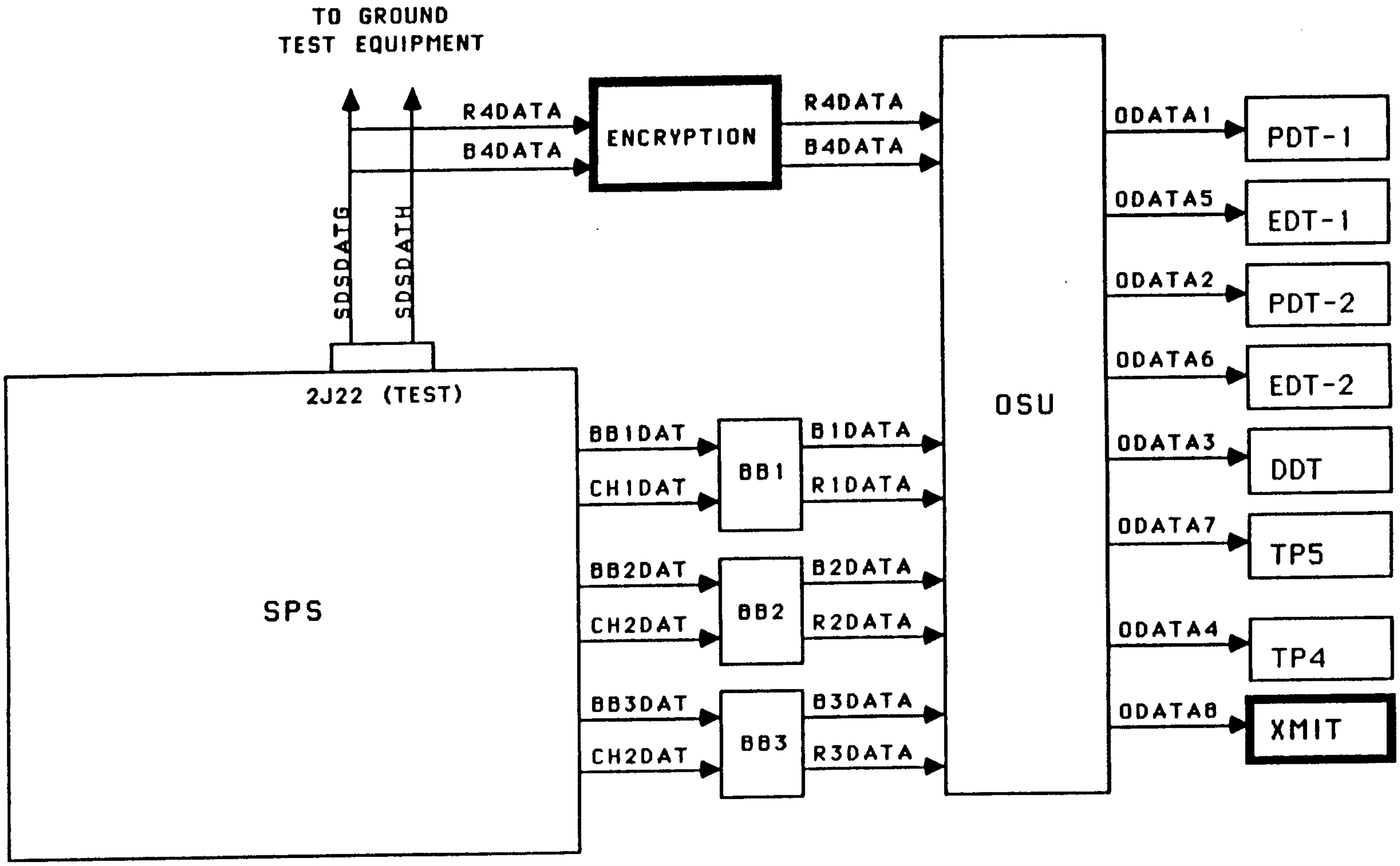


S-BAND/SPACECRAFT APPROACH #3



- Port pre-record data, via channel4, to a new S-Band transmitter
- Utilize SPS test connector to route SDS pre-record data to the OSU
- New carrier frequency is required
- Encryption-compatible
- Advantage: New transmitter/antenna design easily implemented (using modified existing hardware)
- Disadvantage: Carrier frequency not presently receivable by Wraase receiver; frequency downconversion required
- Candidate for long-term approach

S-BAND/SPACECRAFT APPROACH #3



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PROS AND CONS OF S-BAND DIGITAL APPROACH

ADVANTAGES:

- Minimal Satellite Modifications
- Fastest Route To Demonstration System
- Encryption Can Be Added For Operational System
- Mission Sensor Data Transmitted
- Frequency Allocation Not Difficult

DISADVANTAGES:

- Requires Steerable Antenna In Receiving System
  - -Receiving System Relatively Expensive
  - -Shipboard Reception Requires Pitch, Roll, and Heading Stabilization

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REALTIME DATA SMOOTH (RDS) LINK BUDGET SUMMARY

CASE	REQUIRED RECEIVING ANTENNA GAIN	RECEIVING ANTENNA SIZE
1. 2237.5 MHz, SPACECRAFT OMNI ANT, 1.024 MHz SUBCARRIER	25.1 dB	4.0 FEET
2. 2237.5 MHz, SPACECRAFT DIRECTIONAL ANT, 1.024 MHz SUBCARRIER	18.3 dB	1.8 FEET
3. 2237.5 MHz, SPACECRAFT DIRECTIONAL ANT, DIRECT MODULATION	15.4 dB	1.3 FEET
4. 137.5 MHz, TIROS ANTENNA, DIRECT MODULATION, CONVOLUTIONAL CODING	-3.7 dB	OMNI
5. 225 MHz, TIROS-LIKE ANTENNA, DIRECT MODULATION, CONVOLUTIONAL CODING	-3.4 dB	OMNI

NOTE THAT THE S-BAND APPROACHES ALL
REQUIRE DIRECTIONAL (STEERABLE)
RECEIVING ANTENNAS

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LINK BUDGET AT 2237.5 MHZ, OMNI ANT., 1.024 MHZ SUBCARRIER

1.	Transmit power (5W)	+37.0 dBm
2.	Cable losses	5.3 dB
3.	Antenna gain (typical)	0.0 dB
4.	EIRP	+31.7 dBm
5.	Path loss (20° elevation)	164.8 dB
6.	Atmospheric attenuation	0.2 dB
7.	Polarization loss	0.5
8.	Received power	-133.8 dBm
9.	E_b/N_0 required (1 xl O-6 BER)	+10.8 dB
10.	Implementation loss	3.0 dB
11.	Margin	3.0 dB
12.	Subcarrier loss	1.9 dB
13.	C/kTB required	+18.7 dB
14.	kTB (k=-198.6, T=200°K, B=66 kb/s)	-127.4
15.	C required at LNA input	-108.7 dBm
16.	Antenna gain required	25.1 dB
17.	Antenna diameter (40% eff)	4.0 feet

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LINK BUDGET AT 2237.5 MHZ, DIR. ANT., 1.024 MHZ SUBCARRIER

1.	Transmit power (5W)	+37.0 dBm
2.	Cable losses	1.5 dB
3.	Antenna gain (typical)	3.0
4.	EIRP	+38.5 dBm
5.	Path loss (20° elevation)	164.8 dB
6.	Atmospheric attenuation	0.2 dB
7.	Polarization loss	0.5
8.	Received power	-127.0 dBm
9.	E_b/N_o required (1xl 0'6 BER)	+10.8 dB
10.	implementation loss	3.0 dB
11.	Margin	3.0 dB
12.	Subcarrier loss	1.9
13.	C/kTB required	+18.7 dB
14.	kTB (k=-198.6, T=200°K, B=66 kb/s)	-127.4
15.	C required at LNA input	-108.7 dBm
16.	Antenna gain required	18.3 dB
17.	Antenna diameter (40% eff)	1.8 feet

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LINK BUDGET AT 2237.5 MHZ, DIR. ANT., DIRECT MODULATION

1.	Transmit power (5W)	+37.0 dBm
2.	Cable losses	1.5 dB
3.	Antenna gain (typical)	3.0 dB
4.	EIRP	+38.5 dBm
5.	Path loss (20° elevation)	164.8 dB
6.	Atmospheric attenuation	0.2 dB
7.	Polarization loss	0.5 dB
8.	Received power	-127.0 dBm
9.	E_b/N_o required (1 x 10^{-6} BER)	+10.8 dB
10.	Implementation loss	2.0 dB
11.	Margin	3.0 dB
12.	Subcarrier loss	0.0 dB
13.	C/kTB required	+15.8 dB
14.	kTB (k=-196.6, T=200°K, B=66 kb/s)	-127.4
15.	C required at LNA input	-111.6 dBm
16.	Antenna gain required	15.4 dB
17.	Antenna diameter (40% eff)	1.3 feet

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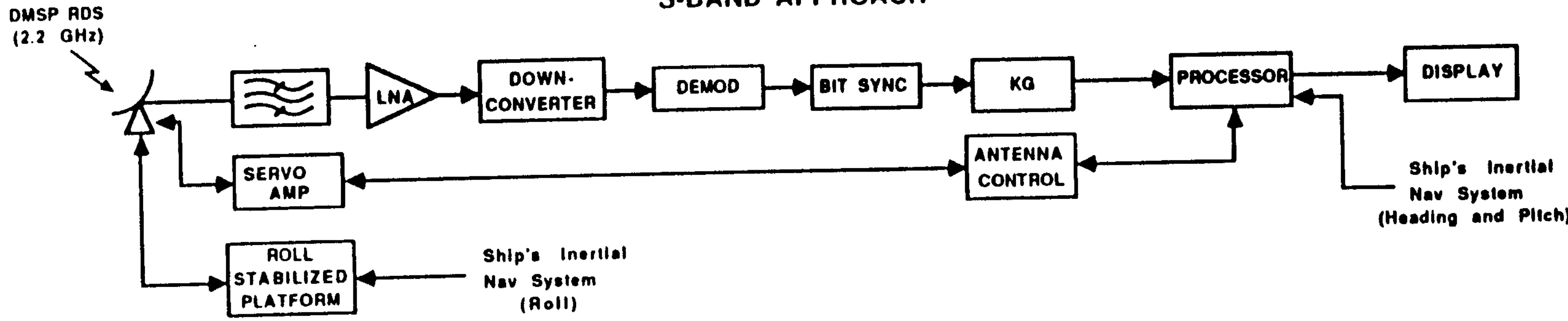
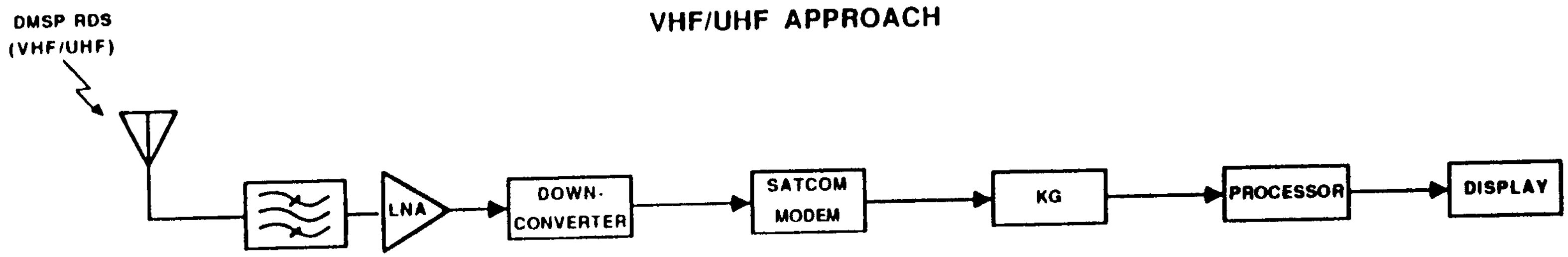
SYSTEMS DIVISION

GENERALIZED BLOCK DIAGRAM FOR SHIPBOARD RDS RECEIVING SYSTEMS

S-BAND APPROACH



VHF/UHF APPROACH



JOM-89 RDS 0004

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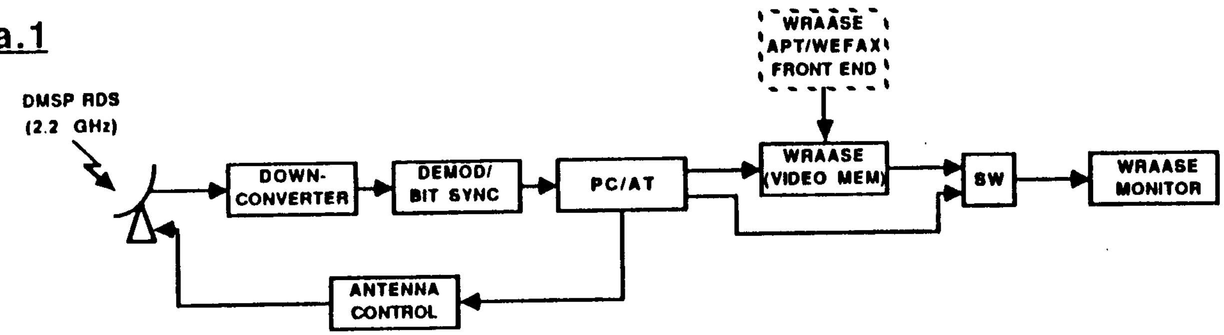
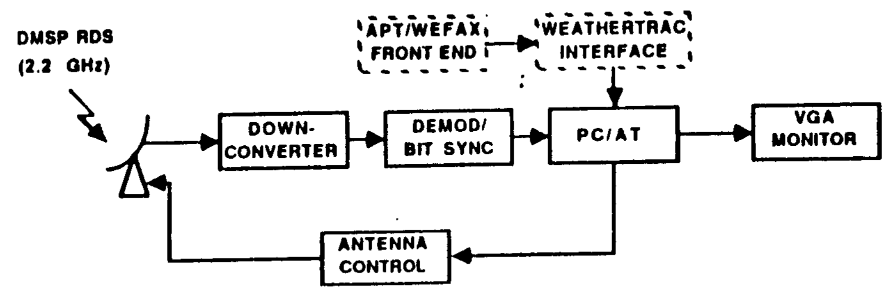
THREE S-BAND DIGITAL APPROACHES FOR RDS RECEPTION

1.a.1

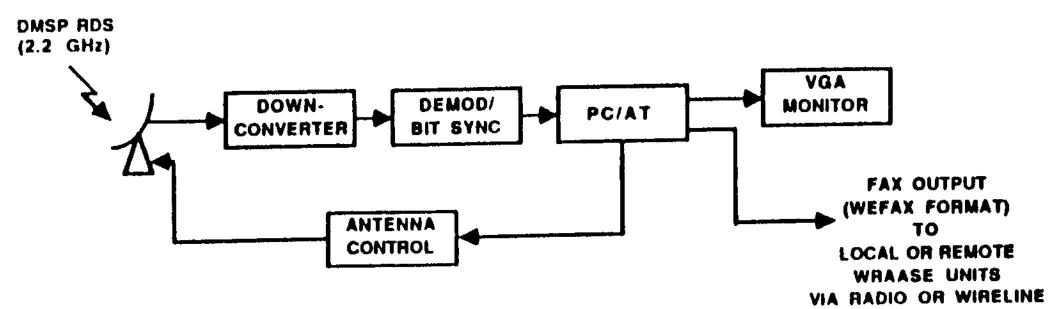


1.b.1



NOTE: LANDBASED VERSIONS SHOWN. SHIPBOARD SYSTEMS ALSO REQUIRE HEADING, PITCH, AND ROLL STABILIZATION

THIRD ALTERNATIVE



ADVANTAGES OF THIRD ALTERNATIVE

- WRAASE EQUIPMENT CAN BE LOCATED REMOTELY FROM RDS RECEPTION POINT, AND CONNECTED VIA WIRELINE OR HF RADIO

- PROVIDES "FORCE MULTIPLIER---A SINGLE RDS RECEIVING SYSTEM CAN SERVE MULTIPLE REMOTE WRAASE UNITS

- ALLOWS SIMULTANEOUS INGEST OF RDS AND EITHER APT OR WEFAX

- INCREASES RELIABILITY-FAILURE OF A WRAASE RECEIVER DOESN'T STOP RDS RECEPTION, PROCESSING, AND DISPLAY

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ANTENNA POINTING APPROACH

- DUE TO THE WIDE BEAMWIDTH OF THE ANTENNA, ONLY PROGRAM TRACKING IS REQUIRED.

- SYSTEM WILL UTILIZE THE NORAD SGP4 MODEL TO DETERMINE SATELLITE POSITION.

    - EPOCH DATA SUPPLIED BY NORAD TWO-CARD ELEMENT SETS.
    - MODEL WILL MAINTAIN SUFFICIENT ACCURACY TO PROGRAM TRACK THE SATELLITE FOR SEVERAL MONTHS BETWEEN EPOCH DATA UPDATES.

- POINTING ALGORITHM REQUIRES ACCURATE CURRENT TIME. THIS IS PROVIDED BY THE PROCESSOR'S INTERNAL CLOCK WHICH WILL BE AUTOMATICALLY UPDATED FROM THE SATELLITE'S CLOCK DURING EVERY TRACKED SATELLITE PASS.

- ON SHIPBOARD APPLICATIONS, THE PROCESSOR WILL OBTAIN SHIP'S ATTITUDE FROM THE SHIP'S INERTIAL NAVIGATION SYSTEM (SINS), IF AVAILABLE, OR FROM AN INDEPENDENT GYROCOMPASS AND VERTICAL GYRO IF SINS IS NOT AVAILABLE.

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LATITUDE/LONGITUDE GRID OVERLAYS

- SYSTEM WILL AUTOMATICALLY PRODUCE LATITUDE / LONGITUDE GRID OVERLAYS.
- THE SATELLITE POSITION WILL BE DETERMINED USING THE LOCATION DATA CONTAINED IN THE RDS DATA STREAM.
- TO IMPROVE GRIDDING ACCURACY, EARTH WILL BE MODELED AS AN OBLATE SPHEROID WITH A POLAR RADIUS OF 6356.912 KM AND AN EQUATORIAL RADIUS OF 6378.388 KM.
- SINCE LOCATION DATA IS PROVIDED IN REAL-TIME BY THE SATELLITE, EXTREMELY ACCURATE CURRENT TIME DATA IS NOT REQUIRED.

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NEED FOR ADDITIONAL FREQUENCY IF RDS USES S-BAND

- Present spacecraft has five transmitters available, but only four different frequencies:

  2207.5 MHz (SD)
  2237.5 MHz (EST or Backup)
  2252.5 MHz (RTD)
  2267.5 MHz (SD)

- All four frequencies will be in use during CRS contacts (SD1 , SD2, and EST to CRS; RTD to Tacterms)

- Tactical users will lose RDS in northern latitudes if the frequencies are shared

- We suggest that a dedicated transmitter and antenna be installed for RDS transmission on a different SGLS channel

- An alternative approach would be to modify the backup transmitter (EDT2) to allow commandable selection of either 2237.5 MHz or another SGLS channel

HARRIS GOVERNMENT INFORMATION SYSTEMS DIVISION	**S-BAND ANTENNA REQUIREMENTS**

1. General: This requirement addresses two versions of a receiving antenna system. Version 1 is a tripod-mounted system for landbased use. Version 2 is a shipboard system and will require a roll-stabilized platform. Reflector diameter is expected to be approximately two feet.

2. Frequency: 2200-2300 MHz

3. Gain: 18.3 dB minimum

4. Antenna Positioner: Equivalent to Tecom Model 203050M

5. Velocity: 0°-30°/Sec (Azimuth), 0°-12°/Sec (Elevation)

6. Electrical Travel: ±200° Azimuth, -10° to +100° Elevation

7. Downconvener Mount: Provisions shall be made for the mounting of a customer furnished downconverter. The downconverter shall be mounted behind the dish in such a way as to minimize cable run from the feed. Downconverter dimensions are approximately 8.5x9.9x2 inches, and downconverter weight is approximately 12 pounds.

8. Counterweights: Counterweight arms shall be furnished if needed for proper positioner performance.

9. Cable Wraps: Cable wraps shall be furnished for downconverter IF output and AC power.

10. Antenna Control: Equivalent to Tecom Model 203346, configured for RS-422 interface from customer furnished computer.

11. Tripod Mount (Version 1 Antenna): A sturdy tripod with appropriate mounting adapter shall be furnished with the antenna. The tripod shall be capable of quick set-up in the field without the need for special tools.

12. Roll Stabilized Platform (Version 2 Antenna): A roll stabilized platform, equivalent to Tecom Model 204680, shall be furnished with the antenna. The platform shall accept 2:1 synchro input from the ship's inertial navigation system.

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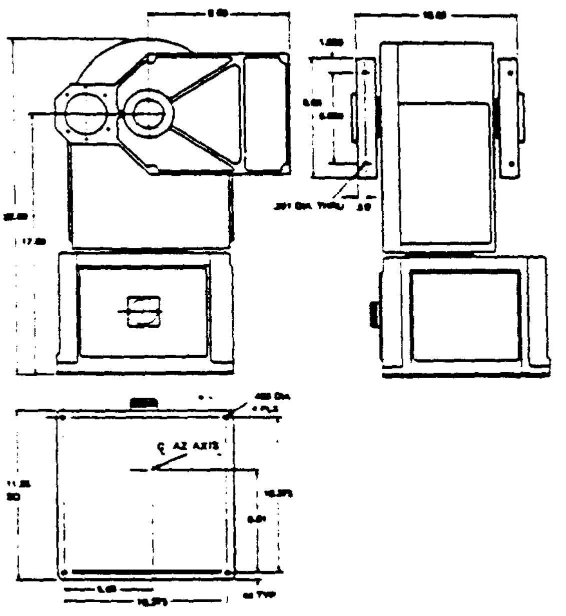
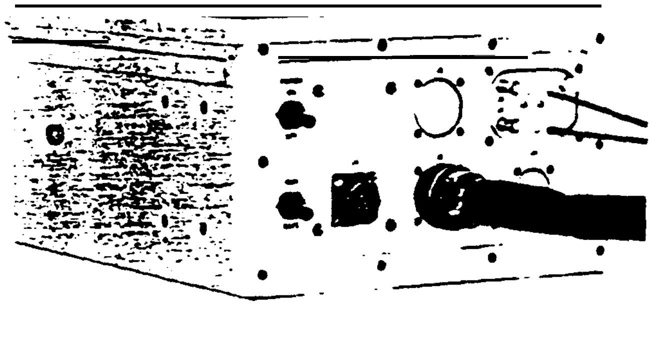
TECOM ANTENNA POSITIONER AND REMOTE CONTROL UNIT

MODEL 203050



TYPE 2033461203259 DIGITAL REMOTE CONTROL UNIT



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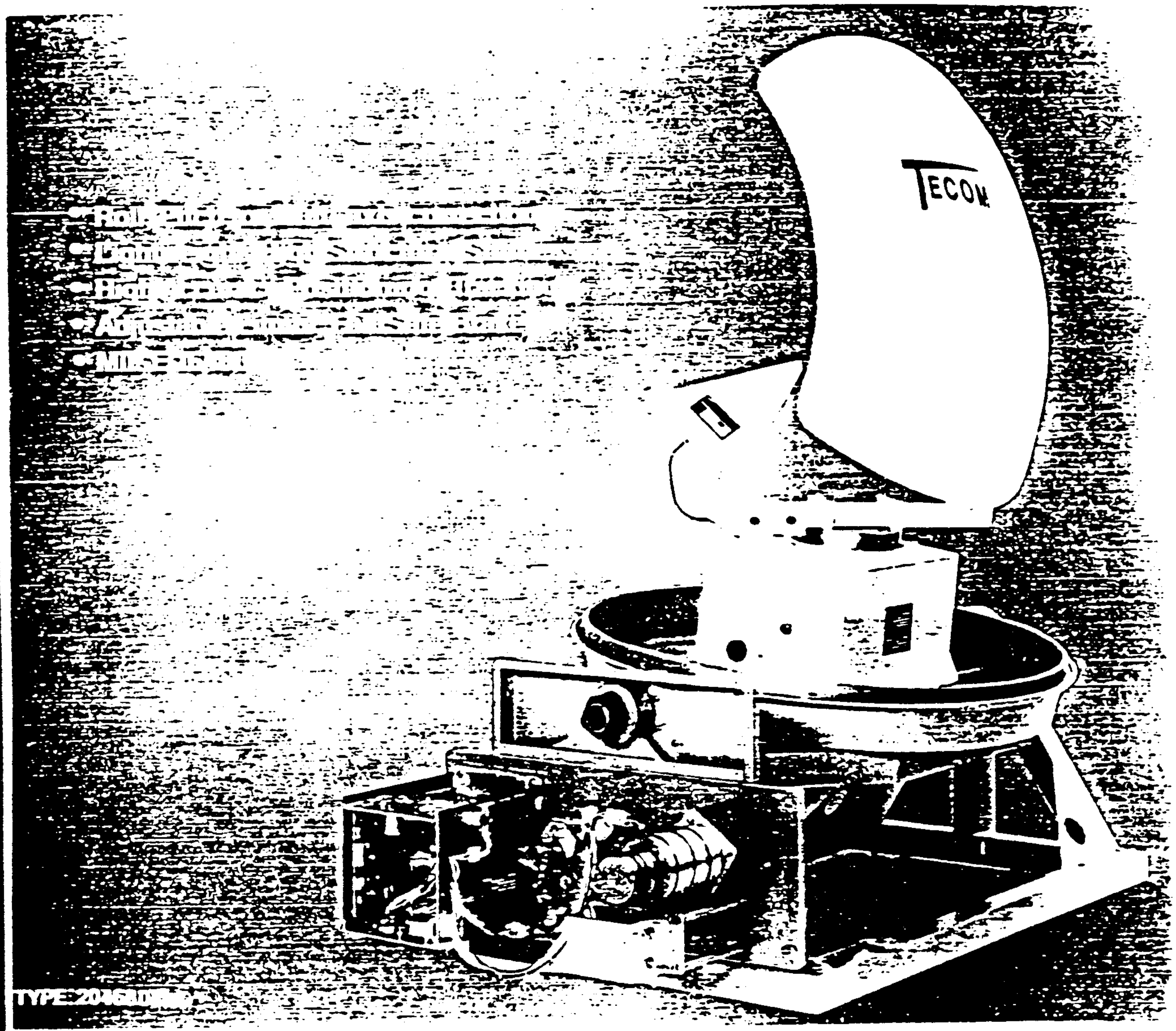
TECOM ROLL STABILIZED SHIPBOARD ANTENNA PLATFORM



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DOWNCONVERTER REQUIREMENTS

1. Input Frequency: 2237.5 MHz.
2. Output Frequency: 70 MHz.
3. Bandwidth: 1 MHz minimum.
4. Frequency Accuracy: ±0.001% for one year without adjustment.
5. Phase Linearity: Within 2°.
6. Input Bandpass Filter: 50 dB minimum rejection over the bands 500-l 400 MHz and 2700-2900 MHz. Insertion loss shall not exceed 0.35 dB.
7. Frequency Stability: One part per million per 24 hours at constant temperature. Five parts per million per 24 hours over the operating temperature range.
8. Phase Noise: Less than 4° RMS when measured with a phase lock receiver with a 20 Hz loop bandwidth and 10 kHz IF bandwidth.
9. Downconvener Status Output: An alarm shall be provided to indicate loss-of-lock status on the phase lock source...The alarm shall be available on an external connector. A sample of the internal DC supply voltage(s) shall also be available on the same connector.
10. Noise Temperature (not including bandpass filter): 75°K maximum at 27°C, 80°K maximum over the operating temperature range.
11. image Rejection: 40 dB minimum.
12. Gain (RF to IF): 95 dB ±3 dB at 80°F.
13. Gain Stability: ±3 dB from 80°F value over the operating temperature range. ±0.05 dB per minute, maximum, at constant temperature.
14. Gain Flatness: ±0.5 dB, maximum, at 80°F. ±0.75 dB, maximum, over the operating temperature range.
15. Gain Compression: An in-band signal of -100 dBm shall not cause more than 1 dB gain compression.
16. Spurious Outputs: Any spurious outputs shall not exceed -50 dBm within 10 MHz of the output center frequency.
17. Input VSWR: 1.5:1, maximum, with respect to 50 ohms.
18. Output VSWR: 2.0:1, maximum, with respect to 50 ohms.
19. Power: 120 volts ±10% at 50/60 Hz ±5%
20. Operating Temperature: 0° F to +104° F
21. Storage Temperature: -40° F to +131° F
22. Enclosure: The downconverter shall be mounted in a weatherproof enclosure with provisions for pressurization.
23. Connectors:
    RF Input: Type N
    IF Output: Type N
    Status: MS with cover
    Power: MS
24. Power Cora: A power cord at least 6’ in length shall be supplied.

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SATELLINK DOWNCONVERTER

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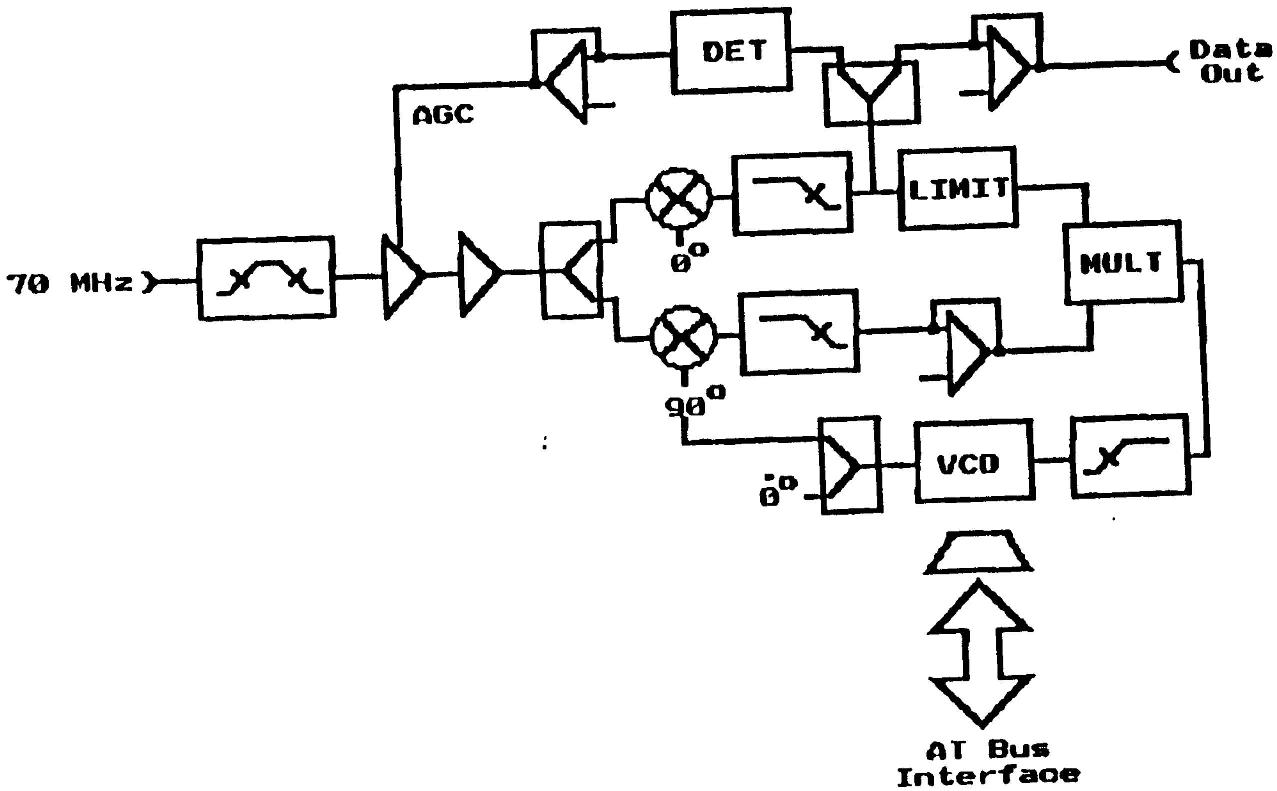
BERG SYSTEMS DEMOD/BIT SYNC BLOCK DIAGRAM



Modernized Costas Loop PSK Demodulator
for
use on the PC/AT Bus

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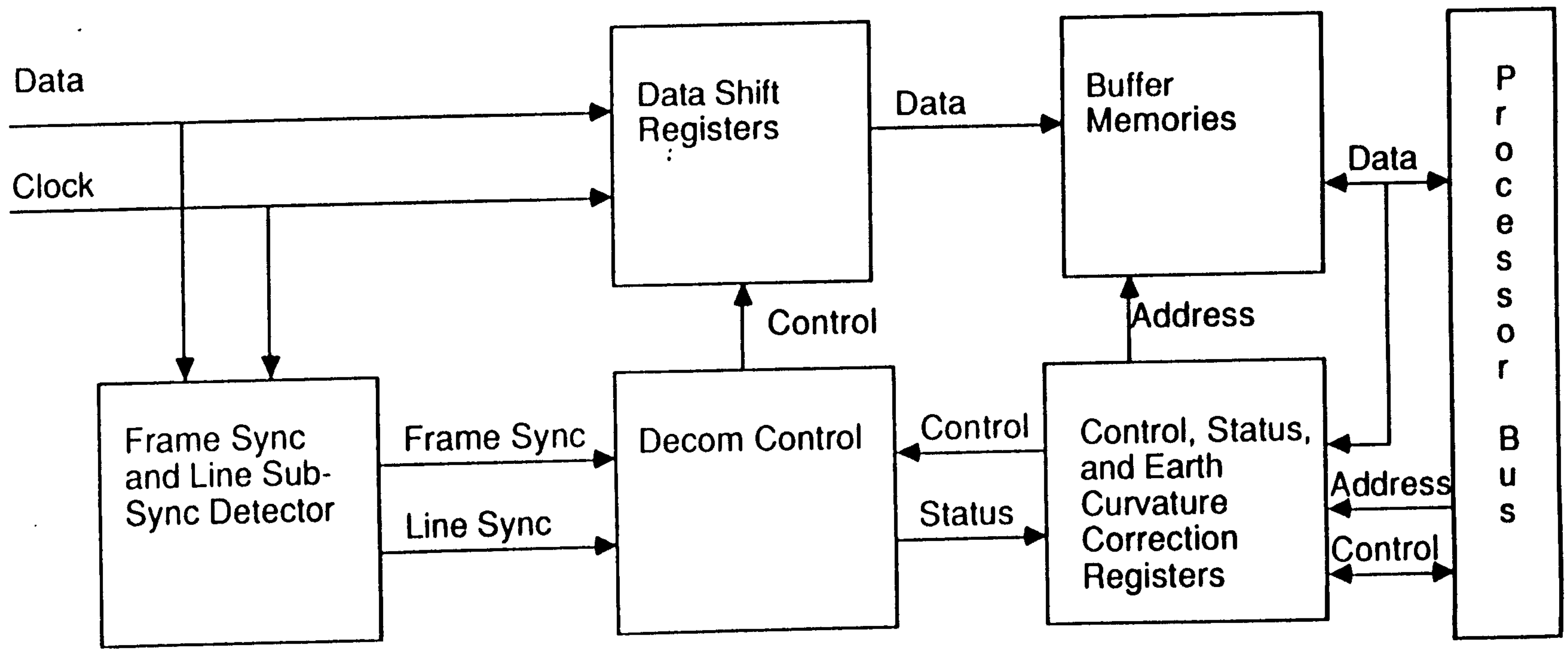
FRAME SYNC/DECOM BLOCK DIAGRAM



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PROCESSOR REQUIREMENTS FOR S-BAND AND VHF/UHF DIGITAL APPROACHES

	ALT 1	ALT 2	ALT 3
AT-Compatible Computer with Floating Point Co-processor and 20MB Hard Disk	X	X	X
8MB EMS Memory	X	X	X
Graphics Adapter	CGA	VGA+	VGA+
RDS Demod/Bit Sync (Note 1)	X	X	X
RDS Frame Sync/Decom	X	X	X
Facsimile Output			X
APT/WEFAX Interface		X	
Synchro to Digital Converter (Note 2)	X	X	X

Note 1: Demod / Bit Sync is external in VHF/UHF approaches.
Note 2: Synchro-to-digital conversion card required only in shipboard S-band approaches.

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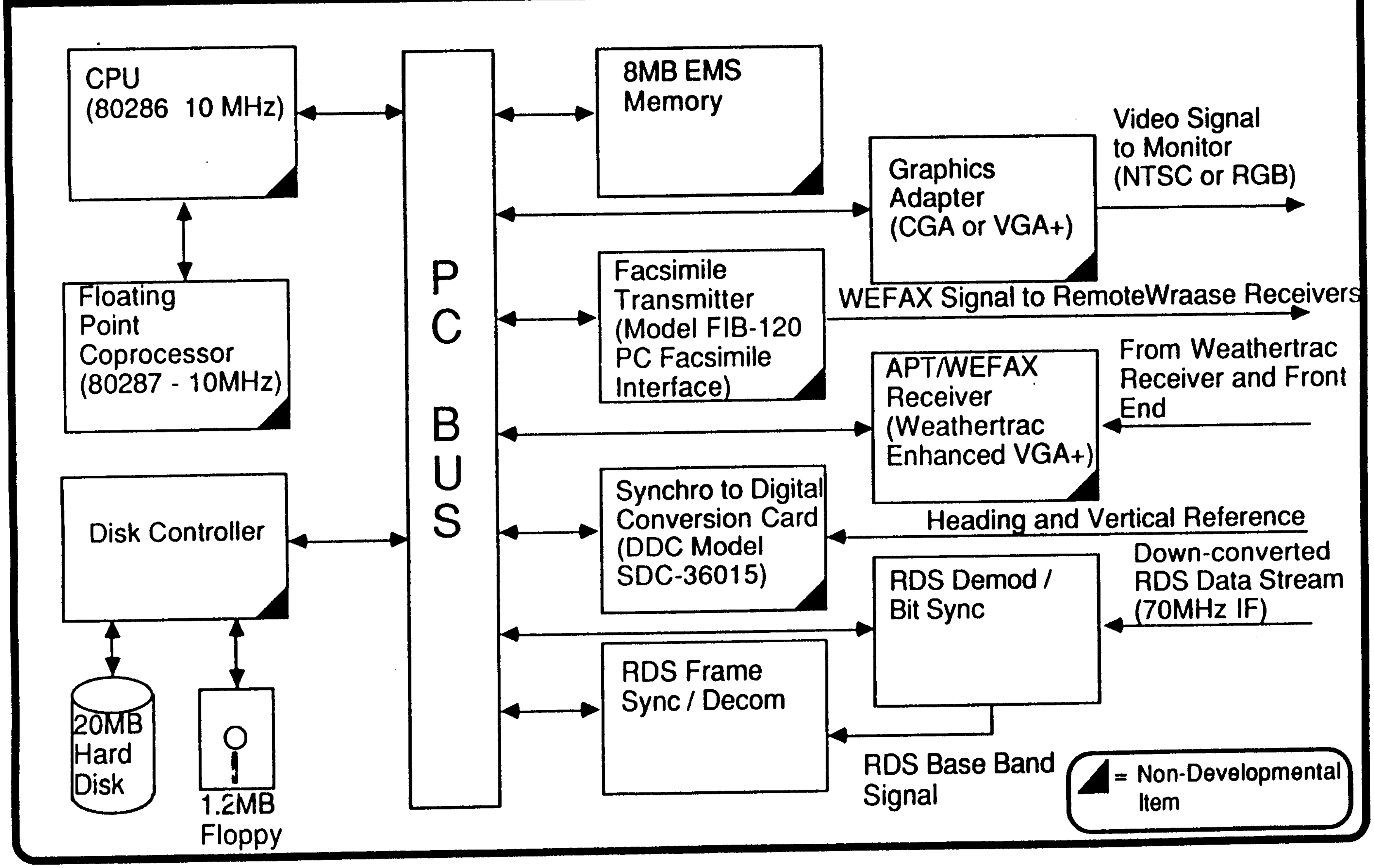
PC/AT Block Diagram



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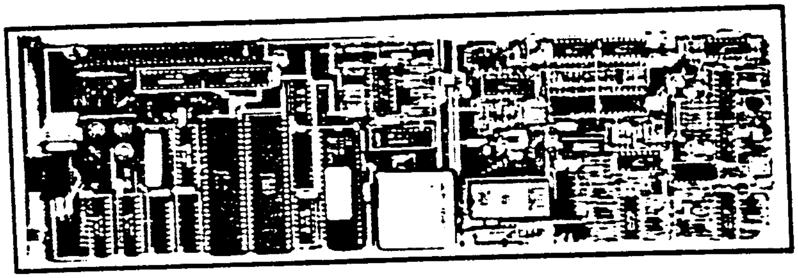
FACSIMILE OUTPUT CARD

PC FACSIMILE INTERFACE Model FIB-120



FEATURES

- Low cost single board
- Digital architecture allows software upgrades to new formats
- Multi-standard reception and transmission formats including AP, UPI, CCITT, GOES, GMS and APT
- Crystal controlled for stability and accuracy
- PC or PC/AT compatible
- Includes software
- Includes a high speed (12MHz) digital computer
- Includes a 600 Ohm balanced telephone interface
- Includes an IBM PC memory bus and I/O bus interface
- High dynamic range, 256 grey levels
- High resolution, 4000 samples per second reception
- Completely software configurable from the IBM PC
- Analogue and digital receive and transmit capabilities

S.C.I.'s PC Facsimile Interface Board, Model FIB-120 is an inexpensive image facsimile receiver/transmitter for the IBM-PC, IBM PC/AT or equivalent. The Model FIB-120 is a single 4" x 13.5" board, that when properly installed, will transform a PC compatible computer into a facsimile transceiver.

The PC board is fully capable of receiving or transmitting high quality continuous tone images in a wide variety of industry standards, such as used in news wireservices and weather satellite picture transmission. The images can easily be acquired to — or transmitted from — a disk or memory of the PC. Multiple line systems can easily be created through the use of more than one board.

With the PC Facsimile Interface Board, one can transform a standard IBM-PC into an imaging workstation that can receive weather photos, news wire service photographs, law enforcement transmissions, and in addition can edit and store those images and then re-transmit them to a remote computer terminal and/or high resolution facsimile recorder or digital receiver.

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WEATHERTRAC INTERFACE

WEATHERTRAC™ Enhanced VGA+ (Grey-Scale) Version
Personal Computer Based Satellite Image Acquisition and Animation System

FEATURES

- Capture APT (Automatic Picture Transmission) images directly from both geo-stationary and polar orbiting weather satellites, such as GOES, TIROS-N, and SOVIET METEOR. Compatible with GOES-TAP, NAFAX, TIROS, GOES-WEFAX, METEOSAT, METEOR, and similarly formatted APT imagery services.
- Capture High-frequency FM (Hf-FM) transmitted FAX images, such as NAFAX.
- Displays captured images as acquired (no waiting) with stunning VGA+ resolutions:
  640x480x 256/256k colors! Includes 64 step grey scale with a quarter million+ other colors!
  480 display lines, scrollable to 800 lines.
  1024x768x 16/256k colors! Includes 16 step grey scale with the same quarter million+ palette!
- Auto-start, auto-synch, auto-header-skip, auto-save, and auto-repeat; fully unattended operation is possible, or any step may be manual. Premature "stop-tone" is detected.
- Mouse Driven Analysis Tools
  HISTOGRAMS on any area, with integrated color palette control.
  PIXEL VALUE CROSSPLOTS on any area.
  FILTERING (Vertical/Horizontal Edge, Sharpening, Median) on any area.
  3-D PROJECTIONS on any area.
  STATISTICS (Mean, standard deviation, minimum, maximum) on any area.
  AREA DUMP TO FILE (binary/ASCII, decimal/octal/hexadecimal) or PRINTER.
  AVHRR/APT AUTOMATED TEMPERATURE CALIBRATION.
- "Loop" Animation from Expanded Memory
  Loop size = 1 + 4 images per each Megabyte of Expanded Memory (1 Meg = 5 images, 2 Meg = 9 images, 8 Meg = 33 images, etc.)
- Hardware PAN and ZOOM
- Instantaneous Retroactive 8-bit Enhancement
  On-line, real-time OR retroactive signal enhancement, with 9 linear scales, 4 logarithmic scales, 4 exponential scales, and 20 operational curves from the NOAA/NESDIS IR Imagery Enhancement Program, including BD, CC, CE, DD, EC, FC, HC, HD, IB, IC, JF, JG, LA, MB, NA, PC, SA, TA, ZA, and ZB.
- Normal ("North-to-South") and reverse acquisition modes, with on-demand image reversal.

SPECIFICATIONS

- System includes WEATHERTRAC audio decoder/interface, data acquisition card, Enhanced VGA+ graphics board, software, and manual. Complete systems including front-end and computer also available.
- Audio decoder has separate inputs for both AM and Hf-FM.
  AM: Accepts 400 mV to 2 Volts input for peak white, externally user adjustable.
  FM: Accepts up to 2 Volts input from speaker, with 1500-2300 Hz FSK.
- Decoder requires 110/60 HZ AC, provides external +12VDC @ 150 mA. (220/60 Hz AC model also available.)
- Audio output of 0.5 Watt for optional user-supplied 8-Ohm speaker, including On/Off switch.
- Raw detected video output and scope synch trigger for video diagnostics.

REQUIREMENTS

- IBM PC/XT/AT or compatible, 512K, 1 diskette drive, NEC Multisync or equivalent. High density drive or hard disk recommended for storing images. Expanded memory required for "loop" animation.
- GOES reception: dish, 1.7 GHz feed, pre-amp, 1.7 GHz-137MHz downconverter, VHF receiver.
  TIROS-N: VHF antenna, 137 MHz VHF receiver.
  Hf-FM: SWL dipole antenna, 2-30 MHz receiver.
- Contact us directly or the dealer below for our latest complete configuration and price sheet.

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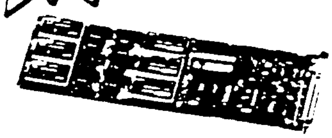
DDC SYNCHRO-TO-DIGITAL CONVERSION CARD

ILC DATA DEVICE CORPORATION

SDC-36015*

IBM PC[3] COMPATIBLE 6 CHANNEL R/D-S/D CONVERTER CARD

NEW



PRELIMINARY

DESCRIPTION

The SDC-36015 is a versatile, full size IBM PC card designed for 1 to 6 channels of Resolver to Digital or Synchro to Digital conversion. The SDC-36015 uses either the RDC-19200 Series (for resolver inputs) or SDC-14560 Series (for synchro inputs) hybrid converters.

The converters feature jumper programmable resolution (10, 12, 14 or 16 bits), programmable high or low bandwidth, and a high quality velocity output voltage (VEL). Output angle information is provided in two 8 bit bytes to the computer.

All information generated by the SDC-36015 is memory mapped in four RAM locations and is available to the computer with a read command. This includes digital angle, 4 bits of turns counting, Built-in-Test (BIT), and Loss-of-Signal (LOS) information for each channel.

APPLICATIONS**

Demonstration software, which shows the SDC-36015 capabilities is available with the card. The multi-channel SDC-36015 is designed for use in test systems and high performance simulation and control systems. With programmable resolution and high accuracy, the SDC-36015 is an excellent choice for applications including motor control, antenna positioning, CNC machine tooling, robot axis control and process control.

FEATURES

- *LOW COST*
- *ACCURACY TO ±1.3 ARC MINUTES*
- *EACH CHANNEL OFFERS:*

  PROGRAMMABLE RESOLUTION & BANDWIDTH

  HIGH QUALITY VELOCITY OUTPUT

  BIT, LOS, AND 4-BITS TURNS COUNTING
- *1 TO 6 CHANNELS*

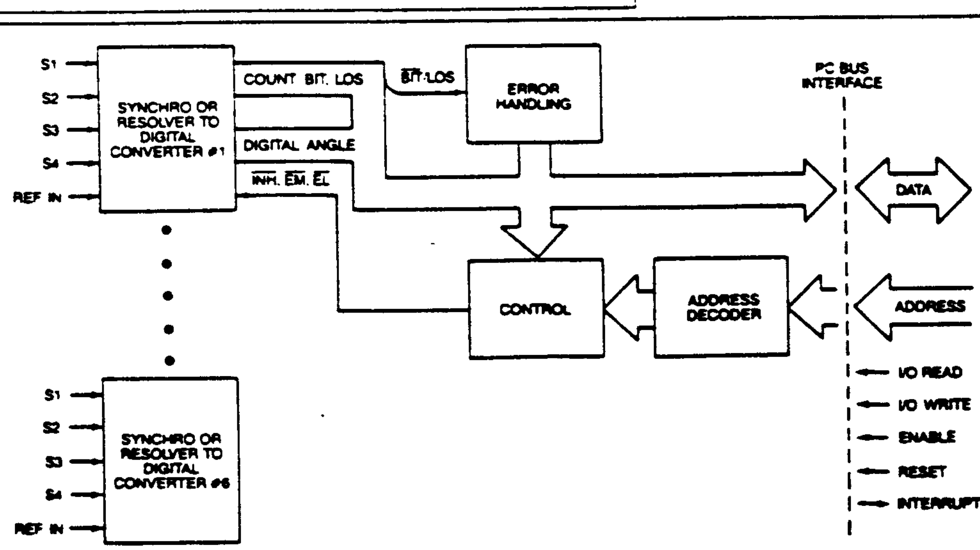
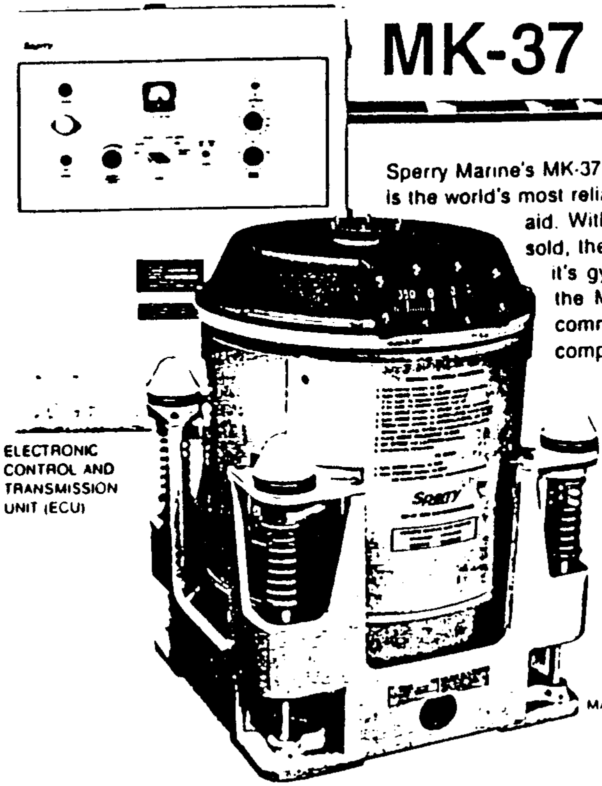


FIGURE 1. SDC-36015 BLOCK DIAGRAM

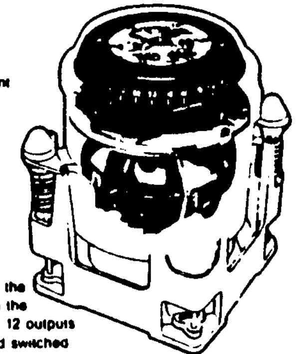
MK-37 MOD E Gyrocompass

Sperry Marine



Sperry Marine's MK-37 MOD E Gyrocompass is the world's most reliable marine navigation aid. With nearly 7000 systems sold, the proven precision of it's gyro element has made the MK-37 series the most commonly specified gyrocompass in the last two decades. The MK-37 delivers performance and reliability.

Master Compass



Shock-mounted fluid filled binnacle which houses the gyro sensitive element is isolated from shock and vibration onboard the ship.

The protection provided to this North-seeking element translates to operational reliability and a virtually maintenance-free life.

Large and clear markings on the compass card provide direct indication of ship's true heading. Illumination is provided for night viewing.

Electronic Control Unit (ECU)

The ECU houses the system electronics, the data transmission system and the speed and latitude compensator. For easy access, controls are mounted on the front panel of the dripproof enclosure. The data transmission system drives 12 outputs of 35, 50 or 70 VDC step data (total 200W) which are individually fused and switched for maximum system integrity. The speed and latitude compensator can optionally be remotely mounted.

Specifications

LINEAR MEAN SETTLE POINT ERROR		±0.19° Secant Latitude
SCORSBY ERROR (±25° ROLL, ±15° PITCH)		0.80° Secant Latitude
ANGULAR FREEDOM		±45° in Roll and Pitch
FOLLOW-UP RATE		Greater than 80°/sec
LATITUDE CORRECTION		Automatic with Manual Latitude Input
SPEED CORRECTION		Automatic with Manual Speed Input
SETTLING TIME		1 Hour (Manually Aided), 5 Hours (Unaided)
OUTPUT		Standard: 35, 50 or 70 VDC Step Data Optional: 1X, 1 and 36X Synchro; Sin/Cos Potentiometer
TEMPERATURE RANGE		41 to 113°F (5 to 45°C)
POWER		
	INPUT	24 VDC, 110/115/220/380/440 VAC, 1 phase, 50/60 Hz
	EMERGENCY	24 VDC, 4.5 Amps (Emergency Alarm and Changeover Unit Available)
	CONSUMPTION	400 VA with Rated Repeater Load

Dimensions and Weights

UNIT	WIDTH (in/mm)	HEIGHT (in/mm)	DEPTH (in/mm)	WEIGHT (Lb/Kg)
MASTER COMPASS	14 5/368	17 5/448	12 8/325	84/38
ELECTRONIC CONTROL AND TRANSMISSION UNIT	20 0/508	26 5/673	7 9/181	120/54.5

Discriminators

- The most accepted and reliable professional gyrocompass in use
- Best overall performance of any commercial gyrocompass
- Twelve repeater outputs, individually switchable
- Speed and latitude compensation
- Large, clear compass card
- Two-unit system simplifies installation and reduces costs
- Fully compliant with IMO Res. A 424(XI)
- Type-approved by DOT, DHI/FTZ, DSRK, PRS, RNR and JRB
- Professional worldwide sales and service support
- Over 75 years in the manufacture and sales of gyrocompass systems

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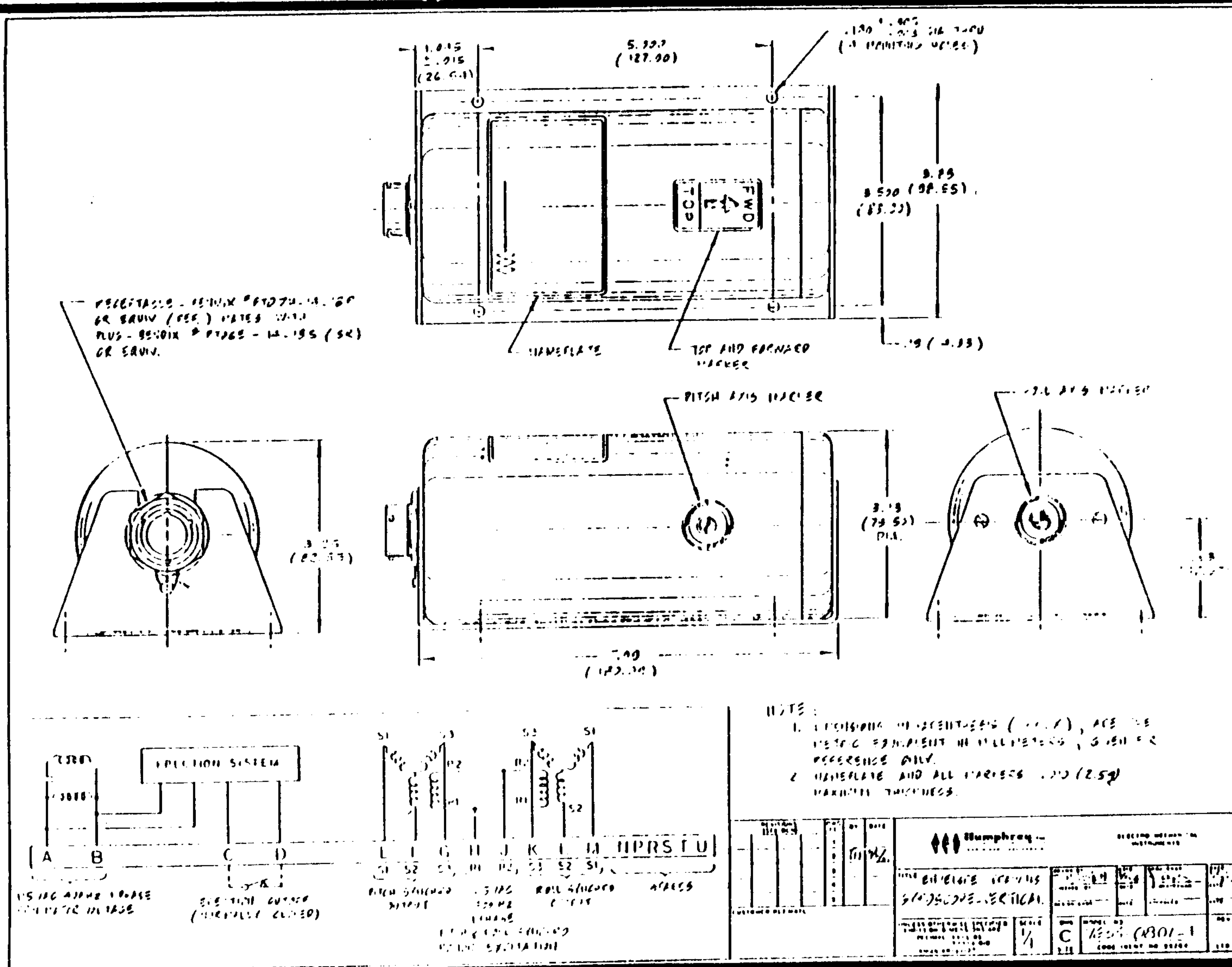
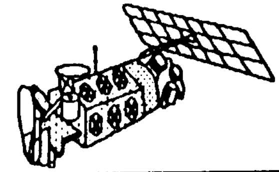
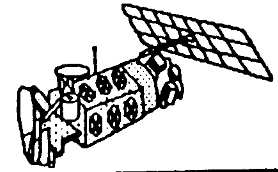
HUMPHREY VERTICAL GYRO





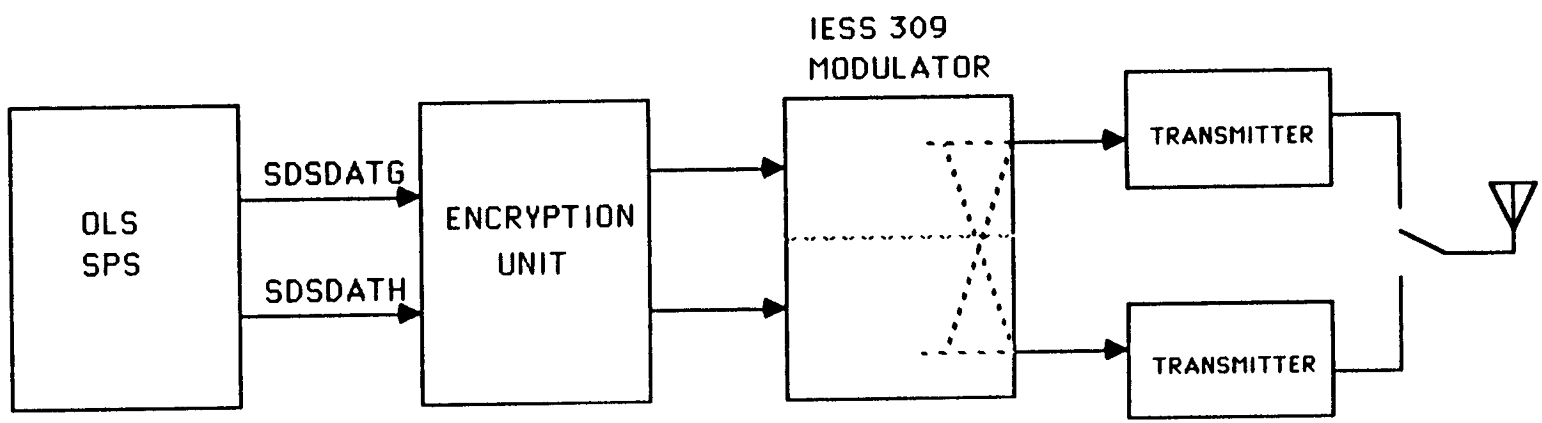
VHF/UHF DIGITAL APPROACHES FOR DMSP

VHF/UHF DIGITAL/SPACECRAFT

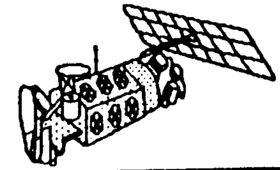


- Route RDS data through OLS SPS to IESS 309 SATCOM modem
- Data output will utilize encryption
- Data transmitted through a dedicated redundant set of digital VHF/UHF transmitters and directional antenna

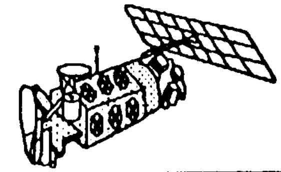
VHF/UHF DIGITAL/SPACECRAFT



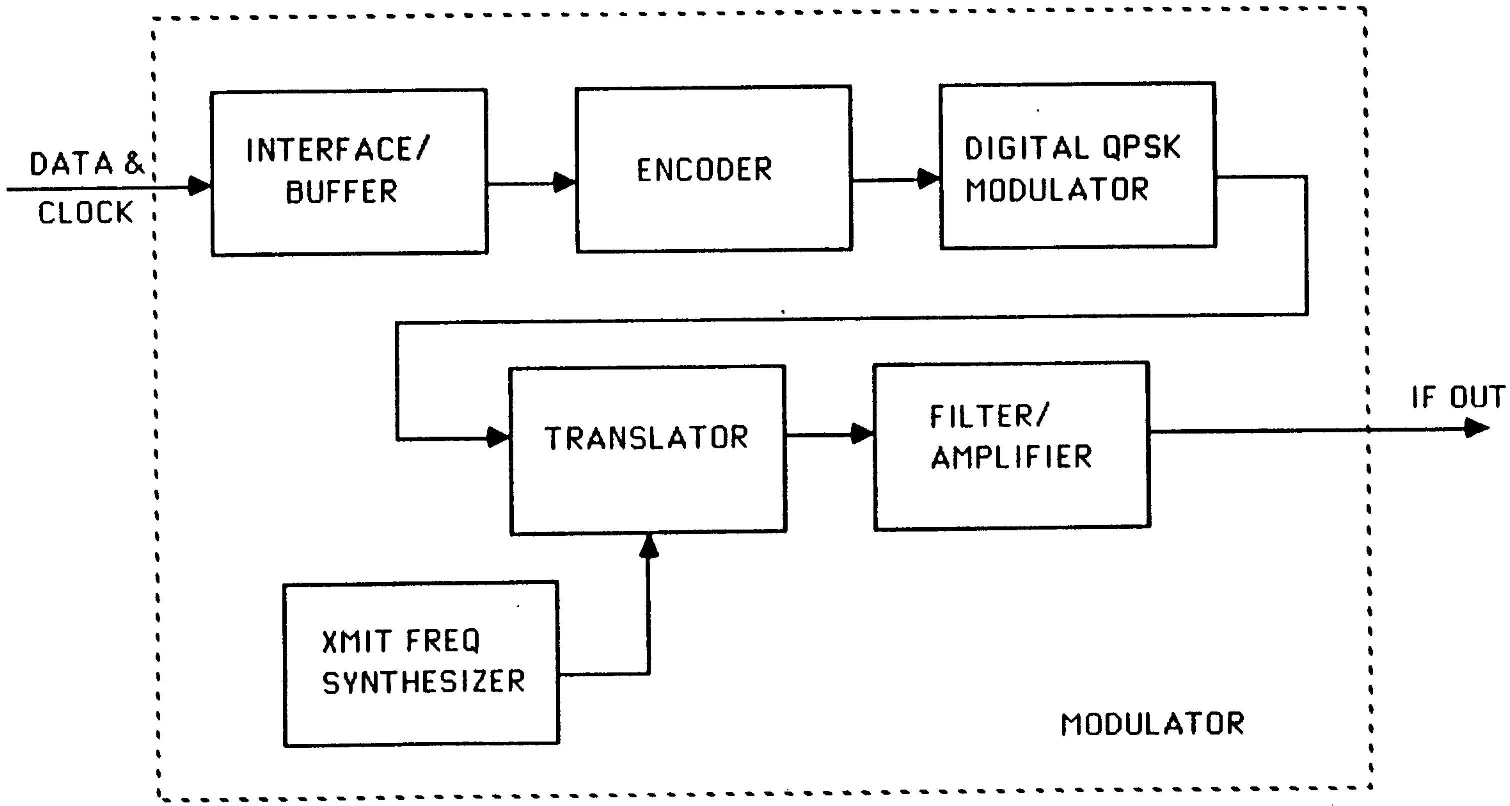
IESS 309 MODEM STANDARD



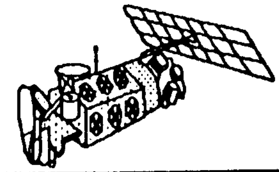
- Commercial standards:
  - Data processing capability includes 66 kbps and 88 kbps
  - QPSK modulation
  - Error correction
  - Output power: -5 to -25 dBm
  - Output frequency: 50-180 MHz



IESS 309 MODEM

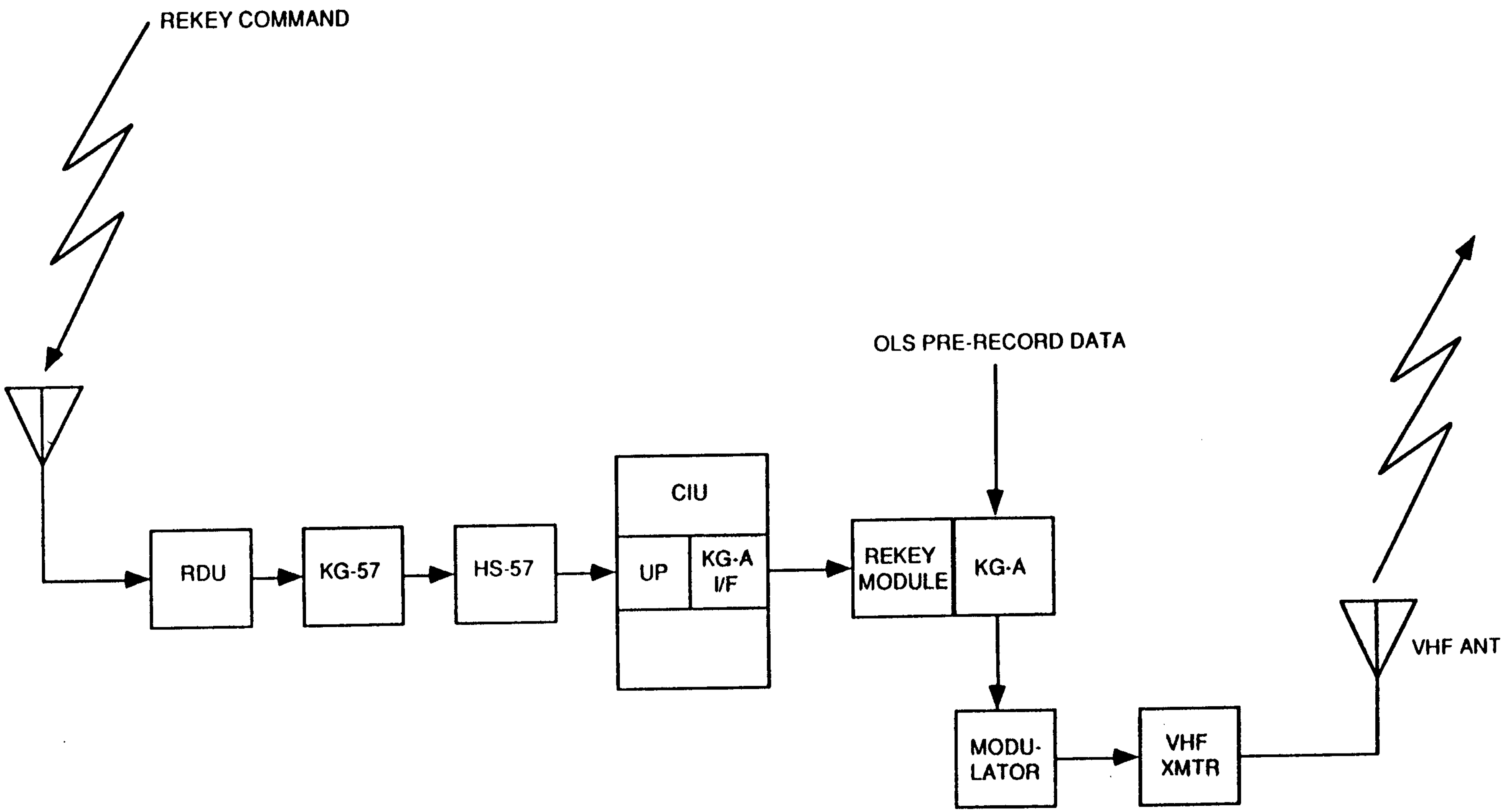


IESS 309 MODEM STANDARD



- Options for design of DMSP spacecraft modem based on the commercial modem:
  - Obtain license from commercial manufacturer to use their design (with modifications) for DMSP only
  - Design unit from scratch per flight requirements
- Required modifications to commercial design:
  - Frequency upconverter if desired carrier frequency is not within designed range
  - Power amplifier to get output signal to +37 dBm

IMPLEMENTATION OF ENCRYPTION



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REALTIME DATA SMOOTH (RDS) LINK BUDGET SUMMARY

CASE	REQUIRED RECEIVING ANTENNA GAIN	RECEIVING ANTENNA SIZE
1. 2237.5 MHz, SPACECRAFT OMNI ANT, 1.024 MHz SUBCARRIER	25.1 dB	4.0 FEET
2. 2237.5 MHz, SPACECRAFT DIRECTIONAL ANT, 1.024 MHz SUBCARRIER	18.3 dB	1.8 FEET
3. 2237.5 MHz, SPACECRAFT DIRECTIONAL ANT, DIRECT MODULATION	15.4 dB	1.3 FEET
4. 137.5 MHz, TIROS ANTENNA, DIRECT MODULATION, CONVOLUTIONAL CODING	-3.7 dB	OMNI
5. 225 MHz, TIROS-LIKE ANTENNA, DIRECT MODULATION, CONVOLUTIONAL CODING	-3.4 dB	OMNI

NOTE THAT THE VHF/UHF APPROACHES
ONLY REQUIRE OMNIDIRECTIONAL
RECEIVING ANTENNAS

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LINK BUDGET AT 137.5 MHZ, TIROS ANT., CONVOLUTIONAL CODING

1.	Transmit power (5W)	+37.0 dBm
2.	Cable losses (insertion and VSWR)	2.1 dB
3.	Antenna gain (alpha=56.0°)	0.5 dB
4.	EIRP	+35.4 dBm
5.	Path loss (20° elevation)	140.6 dB
6.	Atmospheric attenuation	0.2 dB
7.	Polarization loss	0.5 dB
8.	Received power	-105.9 dBm
9.	E_b/N_o required (1×10^{-6} BER)	+10.8 dB
10.	Implementation loss	2.0 dB
11.	Margin	3.0 dB
12.	Coding gain	5.0 dB
13.	C/kTB required	+10.8 dB
14.	kTB (k=-198.6, T=1000°K, B=66 kb/s)	-120.4 dB
15.	C required at LNA input	-109.6 dBm
16.	Antenna gain required	-3.7 dB (Omni is adequate)

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LINK BUDGET AT 225 MHZ, TIROS-LIKE ANT., CONVOLUTIONAL CODING

1.	Transmit power (5W)	+37.0 dBm
2.	Cable losses (insertion and VSWR)	2.1 dB
3.	Antenna gain (alpha=56.0°)	0.5 dB
4.	EIRP	+35.4 dBm
5.	Path loss (20° elevation)	144.9 dB
6.	Atmospheric attenuation	0.2 dB
7.	Polarization loss	0.5 dB
8.	Received power	-110.2 dBm
9.	E_b/N_o required (1×10^{-6} BER)	+10.8 dB
10.	Implementation loss	2.0 dB
11.	Margin	3.0 dB
12.	Coding gain	5.0 dB
13.	C/kTB required	+10.8 dB
14.	kTB (k=-198.6, T=400°K, B=66 kb/s)	-124.4 dB
15.	C required at LNA input	-113.6 dBm
16.	Antenna gain required	-3.4 dB (Omni is adequate)

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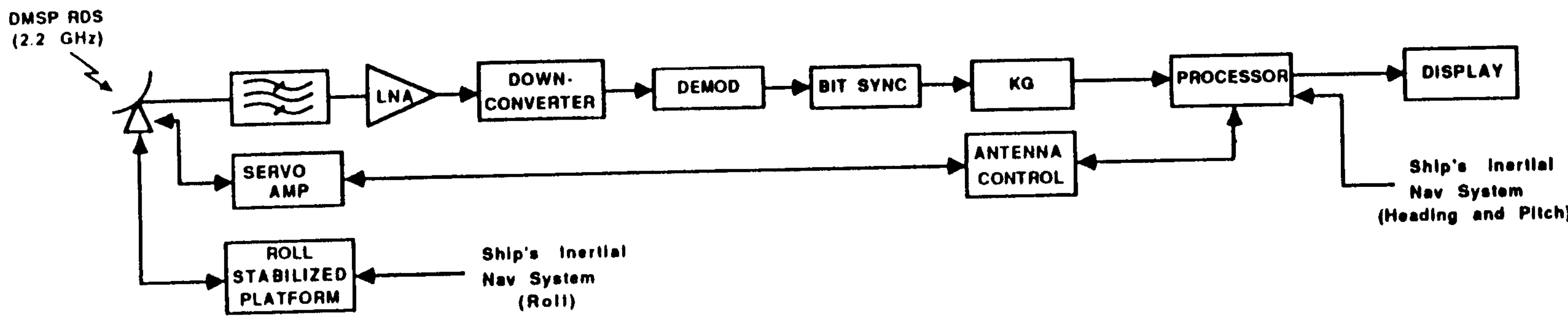
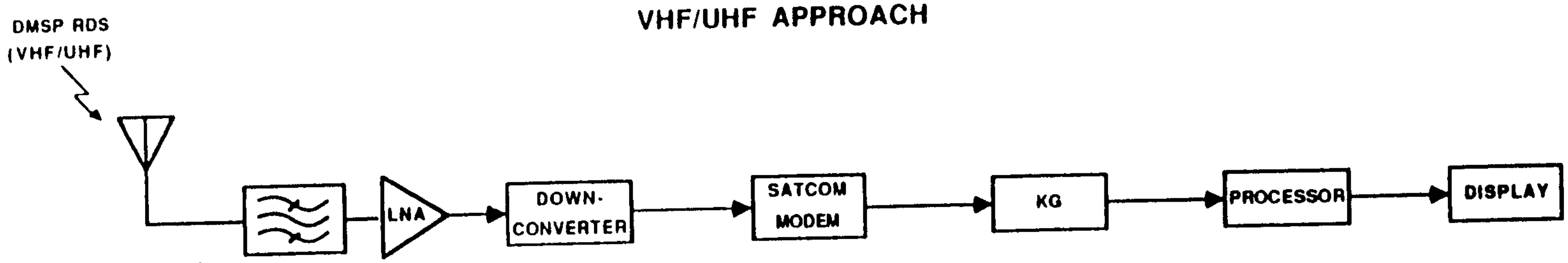
GENERALIZED BLOCK DIAGRAM FOR SHIPBOARD RDS RECEIVING SYSTEMS

S-BAND APPROACH



VHF/UHF APPROACH



JOM 89 RDS-0004

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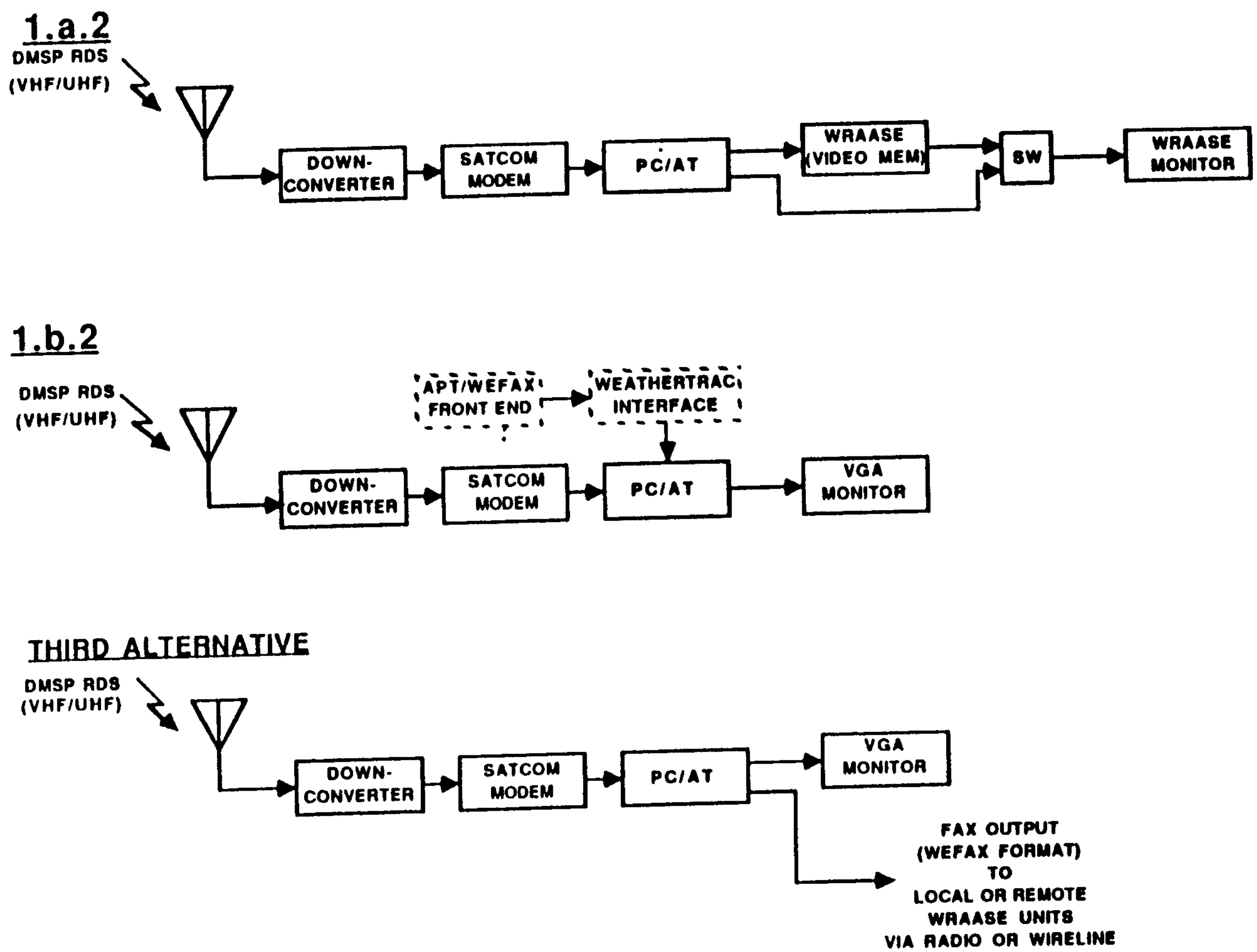
THREE VHF/UHF DIGITAL APPROACHES FOR RDS RECEPTION



ADVANTAGES OF THIRD ALTERNATIVE

- WRAASE EQUIPMENT CAN BE LOCATED REMOTELY FROM RDS RECEPTION POINT, AND CONNECTED VIA WIRELINE OR HF RADIO

- PROVIDES "FORCE MULTIPLIER"--A SINGLE RDS RECEIVING SYSTEM CAN SERVE MULTIPLE REMOTE WRAASE UNITS

- ALLOWS SIMULTANEOUS INGEST OF RDS AND EITHER APT OR WEFAX

- INCREASES RELIABILITY--FAILURE OF A WRAASE RECEIVER DOESN'T STOP RDS RECEPTION, PROCESSING, AND DISPLAY

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NEW SATCOM MODEM STANDARD SUGGESTED IF RDS USES VHF OR UHF

- Previous satcom modems from different vendors were generally incompatible
- There is now a standard for open network satcom modems: Intelsat Earth Station Specification (IESS) 309, which describes modems for the International Business Service (IBS)
- IESS 309 IBS modems are commercial products, available from several vendors
- Use of the IESS 309 standard (less the channel framing feature) would be suitable for transmission of the 66.5 kb/s RDS data
- The modems incorporate forward error correction, providing approximately 5 dB of coding gain
- We recommend use of the IESS standard, if the RDS downlink is moved to VHF or UHF (the higher doppler shift at S-Band exceeds the acquisition range of the available modems)
- This recommendation will be revisited if the study shows that a custom demod/bit sync/Viterbi decoder can be integrated in the RDS processor for the same or lower recurring cost than the commercial modems

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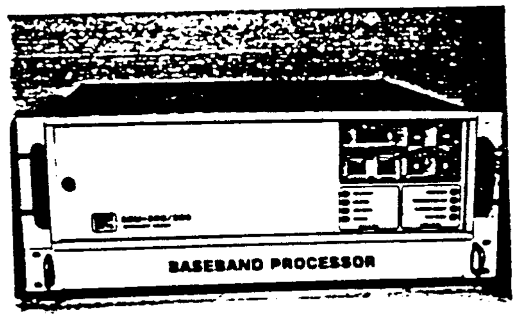
EF DATA MODEM

SDM-309

VARIABLE DATA RATE OPEN NETWORK (IBS) MODEM

64 KB/s to 2.048 MB/s



The EF Data SDM-309 Intelsat compatible modem meets all requirements of the IESS-309 specifications for data rate from 64 KB/s to 2048 KB/s. The SDM-309 provides advanced performance with unsurpassed levels of reliability in a chassis only 5.25" x 19" x 18". The Baseband processor is a separate unit which makes the total height 7 inches. The compact size allows a complete 1:8 system to fit in a single 7 foot rack with room to spare.

MULTIPLE DATA RATES

Each modem is capable of operating at up to four of the different IBS data rates, which are electronically selectable through the monitor and control interface. This enables a 1:8 system to provide backup for modems operating at different data rates. Modulator and Demodulator data rates may be set independently. Data rates from 64 KB/s to 2.048 MB/s are supported. The model SDM-308/N has the capability of providing all of the IBS rates from 64 KB/s to 2048 KB/s.

REMOTE MONITOR & CONTROL

Full remote monitoring and control of all modem functions through an RS-485 (RS-232 is optional) serial link provides unheard of flexibility in a satellite data modem. Each modem is individually addressable over a range of 1 to 255. Address 0 is reserved for global addressing. The current setup of the modem is stored in non-volatile memory that is maintained up to 30 days without external power. The controller monitors circuit card removals and insertions and provides program updates to cards only when necessary. (It even knows when it is removed and reinserted and will learn the current configuration without interrupting service or carry the configuration with it at the operators option.) All functions which may be controlled remotely are also programmable through a front panel keyboard.

BANDWIDTH EFFICIENT

Digital signal processing is used to provide the required open network architecture and to guarantee optimum IESS-309 compatibility.

BASEBAND PROCESSOR

The SDM-309 is compatible with many of the baseband processors on the market today.

EXTENSIVE DIAGNOSTICS

Extensive diagnostic tools are provided by the modem, simplifying initial installation and checkout and offering a high degree of maintainability over the service life of the modem. Such features as digital loopback, RF loopback, bit error rate monitoring, and fault monitoring are provided. In addition, a unique diagnostic tool of the SDM-308 is its ability to store complete modem status information at each occurrence of any fault condition for review when the service technician is available. This feature greatly aids the technician in troubleshooting system problems that invariably occur when no one is around to see them happen. All circuit cards are removable and interchangeable between chassis without readjustment.

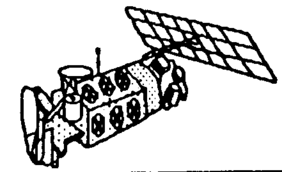
BACK-UP SWITCHING

Other members of our satellite modem family include the SMS-651, 1:1 protection switch and the SMS-658, 1:8 protection switch. Both protection switches are perfect matches for our satellite modems and are available with modems in complete tested systems. The 1:8 switch has the capability to use a modem with three transmit and three received data rates to back up eight on-line modems on three transponders or satellites.

ALL INTERFACES

A full range of industry standard digital interfaces (G703, V.35, RS-449/422, DS-1, etc.) are supported. Changing the interface from one to another is as simple as pulling a circuit card and replacing it with a different one. No special tools or alignment procedures are required.

PROS AND CONS OF DIGITAL VHF/UHF APPROACH

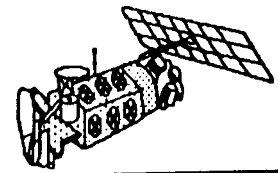


ADVANTAGES:

- Due to lower path loss at VHF/UHF, omnidirectional antenna for receiver is sufficient
- Existing SATCOM modem and TIROS APT antenna design can be modified for spacecraft application
- Existing SATCOM modem is commercially available for ground application

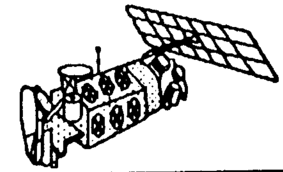
DISADVANTAGES:

- Space-qualified SATCOM modem not presently available
- Custom design to IESS 309 standard for spaceflight use will be needed
- Suitable for long-term approach only



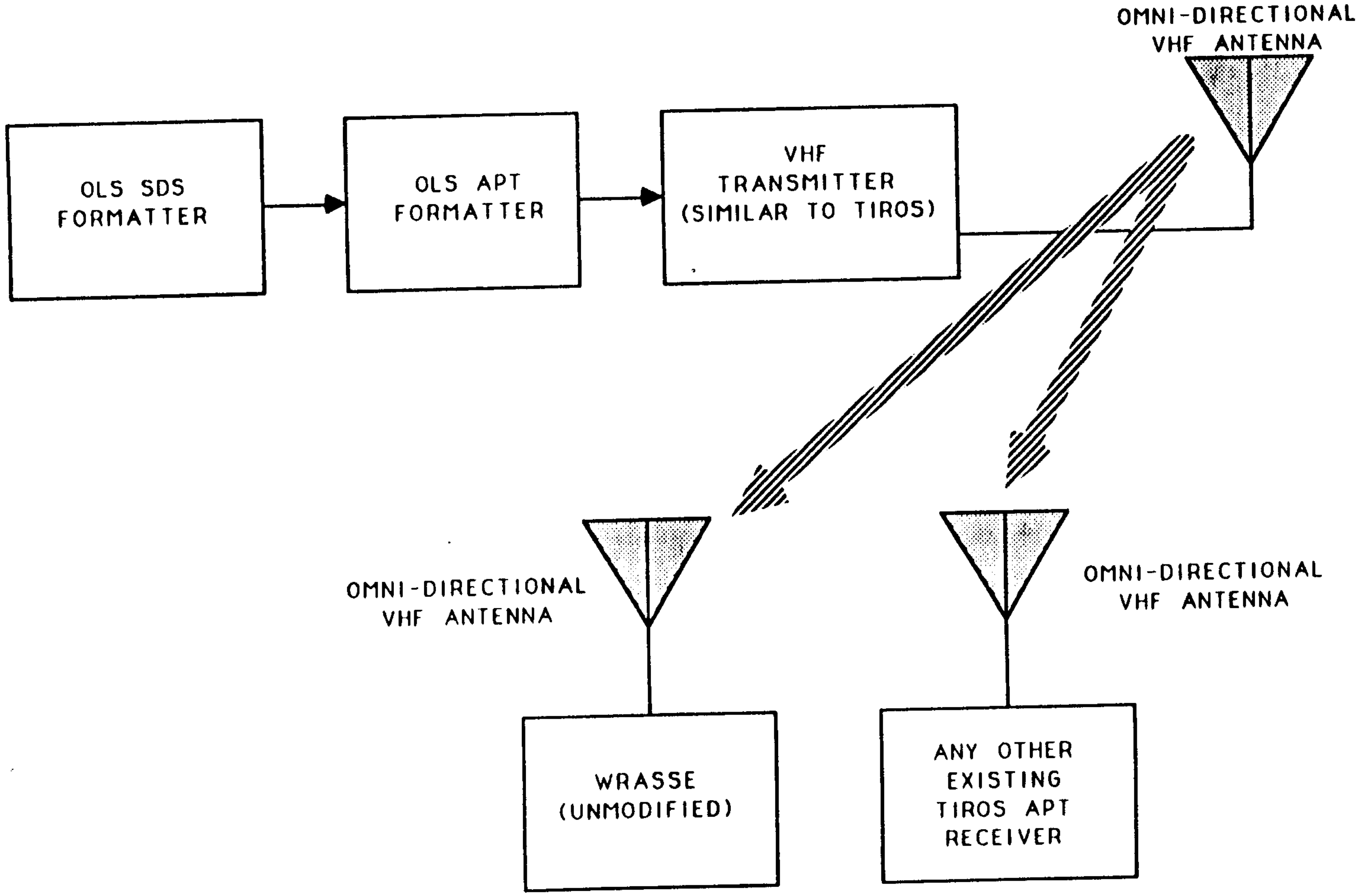
APT APPROACHES FOR DMSP

OLS APT FORMAT DESCRIPTION

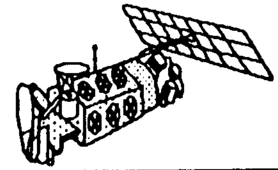


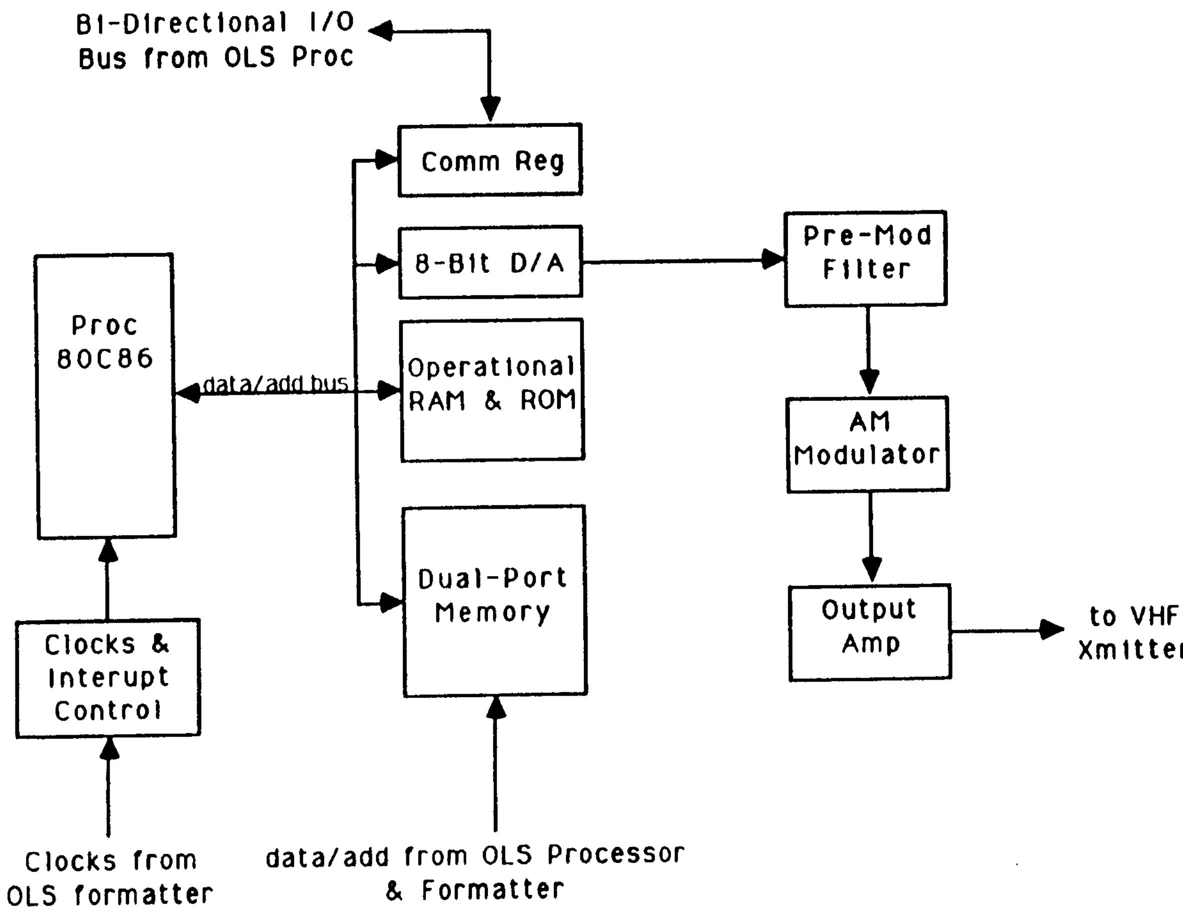
- OLS APT FORMAT WOULD DUPLICATE TIROS APT LINE STRUCTURE AS CLOSELY AS POSSIBLE
  - OLS APT WOULD DROP 1 OUT OF EVERY 25 SMOOTH LINES TO SYNCHRONIZE WITH THE SLOWER TIROS APT LINE RATE (500ms vs 420ms).
  - OLS APT WOULD USE AVERAGING ALGORITHM SIMILAR TO TIROS APT TO CORRECT FOR ACROSS TRACK IMAGE EXPANSION
  - ON BOARD PROCESSING COULD SUPER-IMPOSE GRIDDING AND TEXT ON IMAGE

DMSP APT BLOCK DIAGRAM

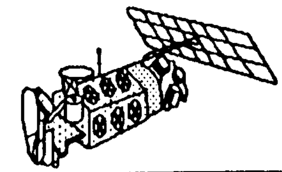


OLS APT Block Diagram



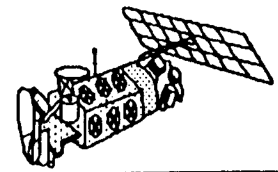


DMSP APT OVERVIEW



- SPACECRAFT IMPACT
  - MODIFY OLS TO PROVIDE APT VERSION OF SMOOTH DATA STREAM
  - ADD MODULATOR/XMTR/ANTENNA TO SPACECRAFT
  - MODIFY SPACECRAFT HARNESS
- GROUND IMPACT
  - ESSENTIALLY NONE
  - WRASSE MAY BE USED UNMODIFIED, ONLY REQUIRES ADDITIONAL OF A CRYSTAL

DMSP APT OVERVIEW



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  - MODIFY SPACECRAFT HARNESS
- GROUND IMPACT
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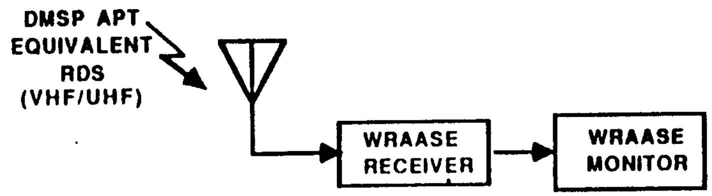
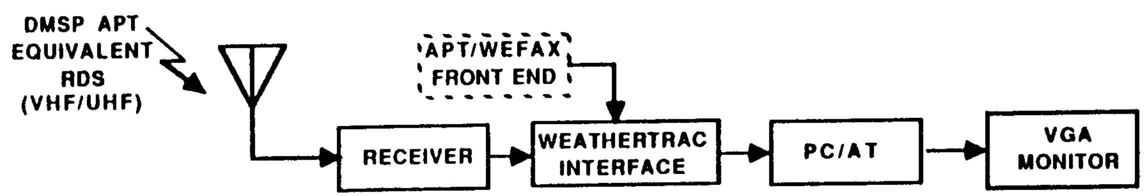
APPROACHES FOR APT RECEPTION

1.a.3



1.b.3



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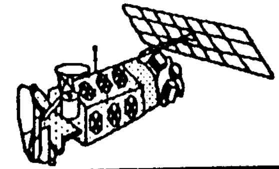
COMPARISON OF RDS AND APT RESOLUTION

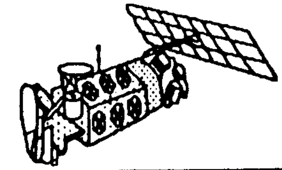
	RDS	APT
PIXELS / LINE	1465	512
LINES / IMAGE (18 minute pass)	2566	1283
ZOOM CAPABILITY:	YES	NO

NOTE: THE RESOLUTION SHOWN FOR APT IS THAT OF THE WRAASE RECEIVER WHEN SET UP FOR APT RECEPTION

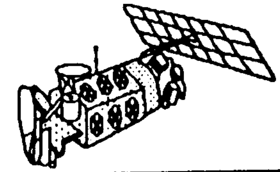


TRADEOFFS

TRADEOFFS



	S-BAND DIGITAL	VHF/UHF DIGITAL	VHF ANALOG (APT)
SPACE SEGMENT			
HARDWARE REQUIREMENTS			
• NEW UNITS	NONE	MODULATOR; XMTR; ANTENNA	MODULATOR; XMTR; ANTENNA
- POWER CONSUMPTION		- TBD	- TBD
- SIZE/WEIGHT		- TBD	- TBD
• MODIFIED UNITS	HARNESS	HARNESS; CIU	HARNESS; CIU; OLS SPS
ENCRYPTION	FEASIBLE	FEASIBLE	NOT FEASIBLE
MISSION SENSOR DATA	AVAILABLE	AVAILABLE	NOT AVAILABLE
FREQUENCY ALLOCATION	NOT DIFFICULT	DIFFICULT	DIFFICULT
COST	LOW	MODERATE	EXPENSIVE
SCHEDULE	S11 AND UP	S14 AND UP	S16 AND UP
GROUND SEGMENT			
ANTENNA COMPLEXITY	COMPLEX, STEERABLE	SIMPLE, OMNIDIRECTIONAL	SIMPLE, OMNIDIRECTIONAL
PERFORMANCE			
• GRIDDING	DERIVED FROMTRANSMITTED EPHEMERIS	DERIVED FROM TRANSMITTED EPHEMERIS	EMBEDDED IN IMAGE
• RESOLUTION	SAME AS SDS	SAME AS SDS	SAME AS TIROS APT
EASE OF USE	MODERATE	SIMPLE	SIMPLE
COST	EXPENSIVE	MODERATE	LOW



RECOMMENDATIONS

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RECOMMENDATIONS FOR THE NEAR TERM (EVALUATION PHASE)

Spacecraft:

- Use the OLS input (direct PSK modulation) of one of the following transmitters:

  EDT 2
  PDT 1
  PDT 2

- Time share the selected frequency with the present usage (EST, SDF, SDS) on a non-interfering basis (RDS is preemptable).

Ground System:

- Develop prototype RDS receiving system

  -2-foot dish on portable az-el mount

  -Integrated demod/bit sync

  -PC-AT class processor with custom deinterleaver/frame sync/ decom card and enhanced VGA graphics

  -640 X 480 monitor with 64 grey levels

  -Facsimile output interface to drive Wraase units

  -Antenna control capable of program tracking with ship-motion compensation

  -No crypto (eases moving the system around for field evaluation)

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RECOMMENDATIONS FOR THE LONG TERM (OPERATIONAL PHASE)

Spacecraft:

- Develop an RDS transmission package with Ricebird crypto, IESS 309 compatible modulator, and VHF or UHF transmitter/antenna. A downlink near 137 MHz would allow use of the TIROS APT antenna design, and would also allow ground stations to use the same antenna and low noise amp for both APT and RDS.

Ground System:

- Replace S-Band receiving equipment with VHF or UHF omni antenna and IESS 309 satcom modem.
- Add Ricebird crypto
- Retain processor and monitor.
- S-Band and VHF/UHF front ends may both be used if the evaluation-phase satellite is still alive.

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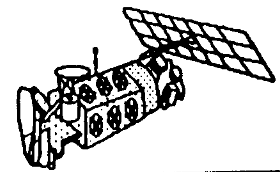
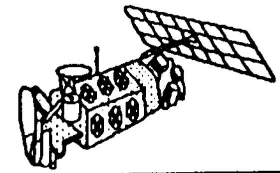
EVALUATION ISSUES FOR PROTOTYPE RDS RECEIVING SYSTEM

1. CAN A SMALL S-BAND ANTENNA TOLERATE THE SHIPBOARD OR LAND-BATTLEFIELD RADIO FREQUENCY INTERFERENCE (RFI) ENVIRONMENT?
2. CAN THE ANTENNA CONTROL SYSTEM ADEQUATELY COMPENSATE FOR THE SHIP'S MOTION?
3. WILL A TWO-FOOT DISH PROVIDE SUFFICIENT GAIN FOR RELIABLE LINK CLOSURE?
4. AT WHAT ELEVATION ANGLE WILL WE RECEIVE USEABLE DATA?
5. DOES OUR PROCESSOR PROVIDE THE FUNCTIONS NEEDED FOR IT TO BE OPERATIONALLY USEFUL?
6. WHAT GRIDDING ACCURACY CAN WE DEMONSTRATE?
7. WHAT CHANGES SHOULD BE INCORPORATED INTO THE SYSTEM BEFORE AN OPERATIONAL VERSION IS BUILT?

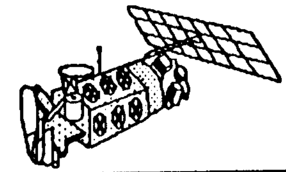


GOALS/OBJECTIVES FOR PROGRESS BRIEFING #2

GOALS/OBJECTIVES FOR PROGRESS BRIEFING #2



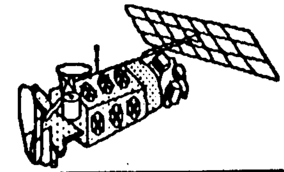
- Provide power/weight estimates for new and/or modified spacecraft units
- Investigate and report on frequency allocation
- Definitize encryption scheme and encryption unit interfaces
- Define DMSP S-Band and TIROS VHF transmitter modifications needed to support the three design approaches
- Provide preliminary layouts for new satellite equipment
- Assess new telemetry signals and commands



OLS REALTIME DATA SMOOTH TRANSMISSION TO SMALL TACTICAL TERMINALS

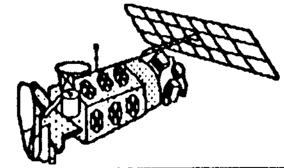
PROGRESS BRIEFING # 2
30 AUGUST 1989

AGENDA



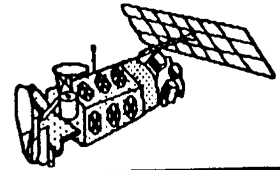
• Realtime Data Smooth Task Overview	GE
• Requirements of Realtime Data Smooth Downlink	GE
• Meeting Objectives	GE
• Result of Progress Briefing # 1	Harris
• S-Band Digital Approach, Short & Long Term	GE/Harris/WEC
• Link Definition / Block Diagrams	
• Satellite Design Modifications	
• Ground System Configuration	

AGENDA (CON'T)



• VHF / UHF Digital Approach	GE/Harris/WEC
• Link Definition / Block Diagrams	
• Satellite Design Modifications	
• Ground System Configuration	
• APT Approach	GE/Harris/WEC
• Link Definition / Block Diagrams	
• Satellite Design Modifications	
• Ground System Configuration	
• Definition of Encryption Scheme / Units	GE /Harris
• Frequency Allocation	GE

AGENDA (CON'T)

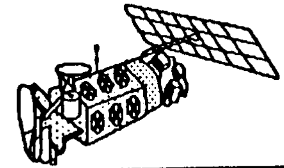


• Tradeoffs	GE/Harris/WEC
• Recommendations	GE/Harris/WEC
• Goals/Objectives for Briefing # 3	GE
• Open Issues	GE

REALTIME DATA SMOOTH

TASK OVERVIEW

TASK OVERVIEW

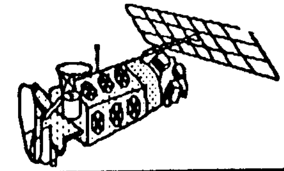


- Space Systems Division has issued task assignments to WEC, Harris, and GE to study methods for providing a new tactical data link for DMSP, receivable by small terminals

- The three co-contractors are cooperating on a study to investigate and recommend modifications to the current DMSP system to provide a Real Time Data Smooth down-link compatible with the Wraase receiver system or alternative candidate receivers

- Ultimate goal is widespread deployment of DMSP-compatible small tactical receivers (all Army field units, all Navy ships, and all Air Force bases)

TASK OVERVIEW (CONT'D)



- SSD wants short-term (in 2-3 years) demonstration on a 5D-2 satellite; operational system is goal for 5D-3 (S15-S20)
- Products of study will be:
  - Report describing:
    - Recommended configuration for short-term demo system for 5D-2
    - Recommended configuration for an operational system for 5D-3
  - Functional specification for an operational system for 5D-3, upon USAF acceptance of approach selected
- Report will include trade-off analyses, required hardware/ software modifications (satellite and ground) for selected configuration, and ROM cost and schedule estimates

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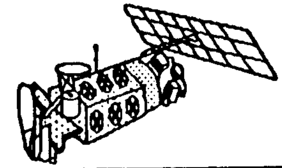
SYSTEMS DIVISION

THE NEED FOR REALTIME DATA SMOOTH (RDS)

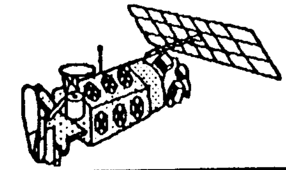
WHY RDS?

TO PROVIDE TACTICAL USERS WITH A SURVIVABLE SOURCE OF ENCRYPTED WEATHER DATA, RECEIVABLE BY A SMALL PORTABLE TERMINAL, THAT WILL NOT BE TURNED OFF IN TIME OF CONFLICT!



REQUIREMENTS OF REAL-TIME DATA SMOOTH DOWNLINK

REQUIREMENTS OF RDS DOWNLINK



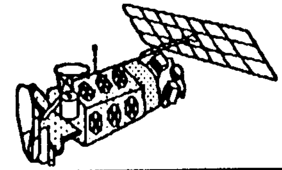
- Use of one of three downlink schemes:
  - S-Band digital
  - VHF/UHF digital
  - VHF analog (APT - equivalent)

- Wraase (or alternative) small tactical receiver compatibility

- Use of existing OLS 66.56 Kbps pre-record RDS data (88.746 Kbps for S16-S20)

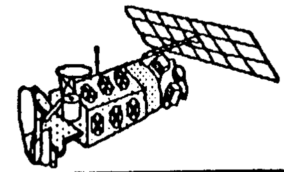
- Encryption for Long-term and Short-term systems, with dynamic re-keying highly desirable for the long-term operational system

- Simple scheme to grid (earth-locate) data



MEETING OBJECTIVES

MEETING OBJECTIVES



- Present design concepts for a short-term demonstration system on a 5D-2 satellite, and for a long-term fieldable system for 5D-3 satellites

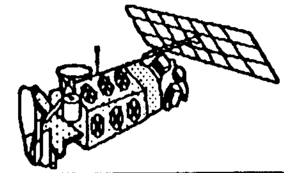
- Present Spacecraft & Ground System Design modifications necessary to implement the three link design approaches

- Report results of investigation on frequency allocation

- Present encryption scheme

- Present design tradeoffs considered during first phase of the study

- Provide initial recommendations for optimum implementation of demonstration and fieldable systems



RESULTS OF PROGRESS BRIEFING # 1

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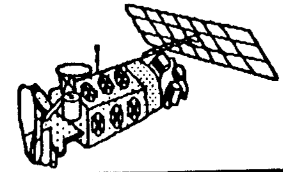
CHANGES RESULTING FROM BRIEFING #1

- ENCRYPTION HAS BEEN ADDED TO THE DESIGN BASELINE FOR THE DEMO SYSTEM

- IESS 309 SATCOM MODEMS HAVE BEEN REPLACED BY BPSK MODULATORS AND DEMODULATORS TO SIMPLIFY SYSTEM DESIGN

- DESIGN APPROACHES USING NTSC VIDEO AS THE PRIMARY RDS DISPLAY HAVE BEEN DROPPED IN FAVOR OF APPROACHES USING RGB VIDEO

PROGRESS SINCE BRIEFING # 1



- Generated power and weight estimates for new spacecraft units for three approaches
- Evaluated VHF/UHF transmitter/antenna designs
- Determined telemetry and command signals requirement
- Determined location for new spacecraft units
- Generated design of encoder and data conversion circuit

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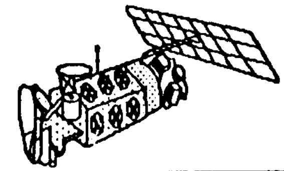
PROGRESS SINCE BRIEFING #1

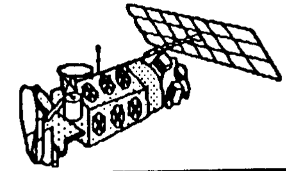
- FINALIZED THE SIX RECOMMENDED DESIGN APPROACHES
- DEVELOPED DETAILED APPROACH FOR ANTENNA POINTING CALCULATION
- PERFORMED COMPUTER ANALYSIS OF THE EFFECTS OF EPHEMERIS AGE ON ANTENNA POINTING ACCURACY
- DEVELOPED DETAILED APPROACH FOR EARTH CURVATURE CORRECTION
- DEVELOPED DETAILED APPROACH FOR GRIDDING AND EARTH-LOCATION CALCULATION



Tom Eastman

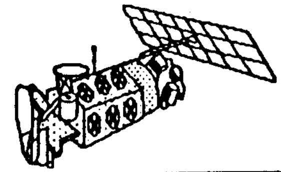
S-BAND DIGITAL APPROACHES FOR DMSP REALTIME DATA SMOOTH

S-BAND APPROACH OVERVIEW



- S-Band digital approaches for RDS data transmission:
  - Approach #1:
    - Unencrypted: Route RDS data directly to OSU. Use existing transmitter (PDT-2) to transmit data. Use clock from SPS test connector
    - Encrypted: Route RDS data to an additional black box transmitter (BBT4). Route encrypted data to OSU. Use existing transmitter (PDT-2) to transmit data. Use clock from SPS test connector

S-BAND APPROACH OVERVIEW



- Approach #2:

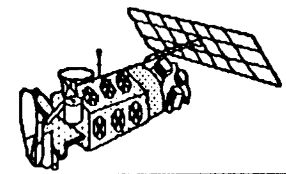
  - Route RDS data to an additional black box transmitter (BBT4), using clock generated within OSU. Route encrypted data to OSU. Use existing transmitter (PDT2) to transmit data

- Approach #3:

  - Route RDS data to an additional black box transmitter (BBT4) through OSU. Route encrypted data to OSU. Use a redundant pair of S-Band transmitters to transmit data (at new S-Band carrier frequency)

Mike Epperly

S-BAND APPROACH - SENSOR IMPACT

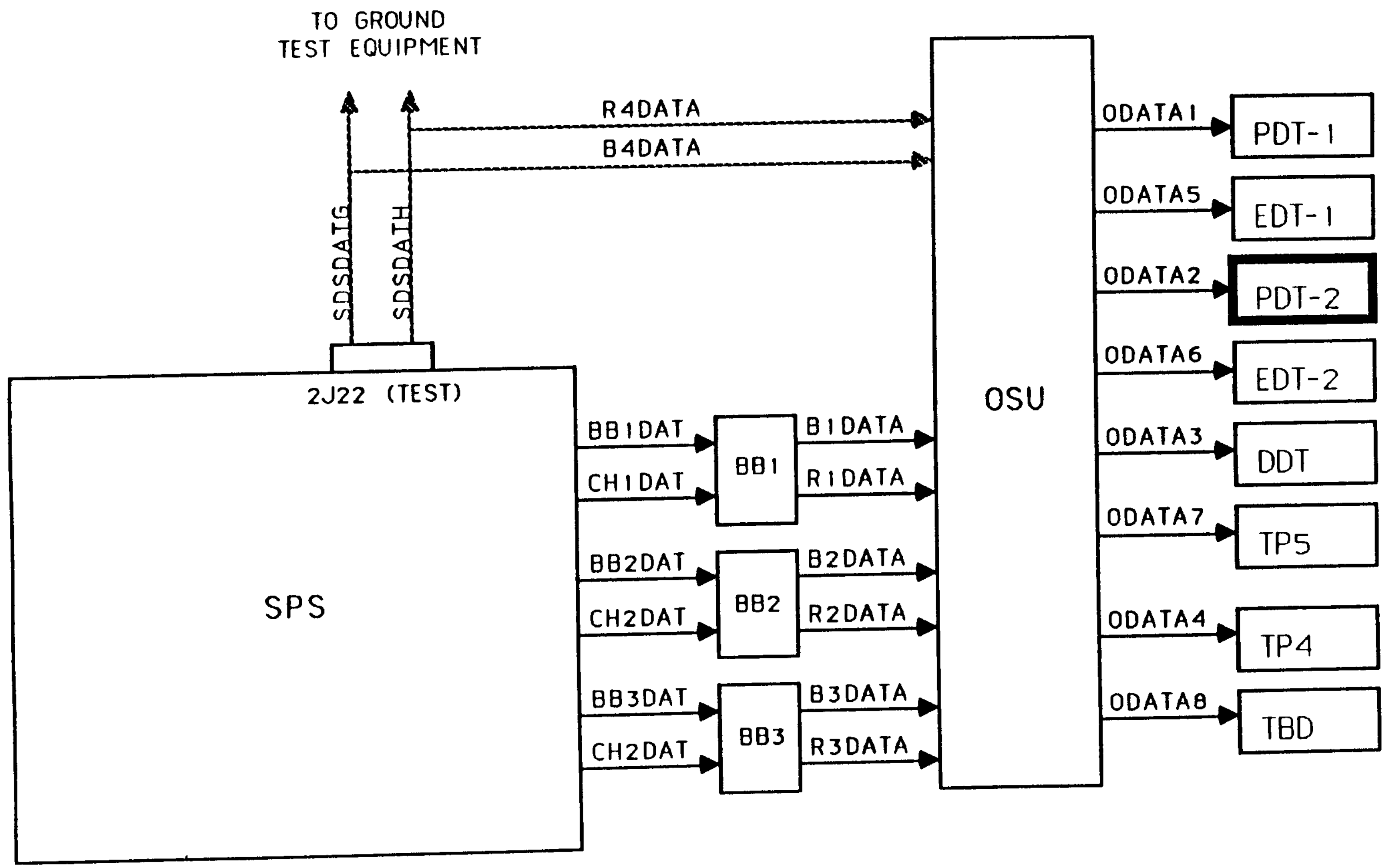


- THERE ARE THREE APPROACHES FOR PROVIDING RDS TO THE S-BAND TRANSMITTERS:
  - APPROACH #1 UTILIZES A TEST CONNECTOR ON THE SPS TO ROUTE RDS TO UNUSED DATA INPUTS ON THE OSU
    - LOWEST COST - LOWEST IMPACT TO SPACECRAFT
    - ENCRYPTION MAY BE POSSIBLE - INVESTIGATION RESULTS TO BE PRESENTED AT LAST BRIEFING
  - APPROACH #2 ALSO UTILIZES THE SPS TEST CONNECTOR BUT MODIFIES THE OSU TO PROVIDE A CLEAN ENCRYPTER CLOCK AND NRZ-L TO NRZ-M CONVERSION
    - MEDIUM IMPACT APPROACH
    - NRZ-M CONVERSION REDUCES GROUND COMPLEXITY
  - APPROACH #3 DOES NOT USE THE TEST CONNECTOR AND REQUIRES MODIFICATIONS TO BOTH THE SPS AND OSU
    - GREATEST IMPACT
    - MORE PERMANENT APPROACH - SIMPLE TRANSITION TO FINAL APPROACH

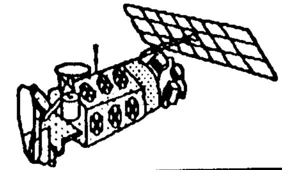
S-BAND APPROACH #1 W/O ENCRYPTION - OLS

- THE S-BAND APPROACH #1 REQUIRES NO CHANGES TO THE OLS
  - SMOOTH DATA FROM THE G AND H FORMATTERS ARE AVAILABLE ON A TEST CONNECTOR USED FOR GROUND TESTING
  - IN OPERATION SDS-G AND SDS-H WOULD BE ROUTED TO B4DATA AND R4DATA RESPECTIVELY IN THE OSU
  - THE OSU WOULD ROUTE THE SMOOTH DATA TO THE APPROPRIATE TRANSMITTER (PDT-2)
  - REQUIRES ONLY THE ADDITION OF NEW CABLE

S-BAND #1 W/O ENCRYPTION



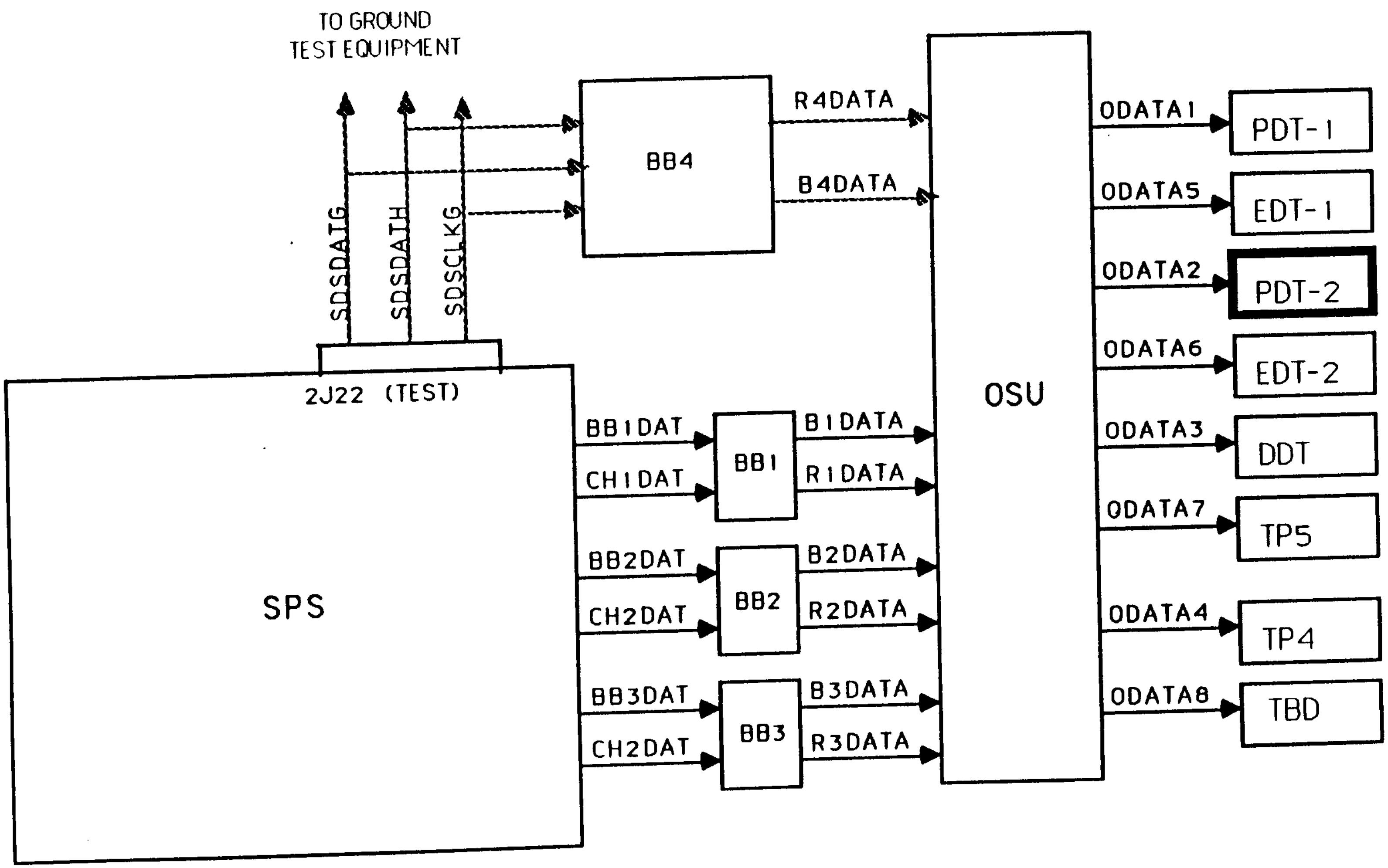
S-BAND APPROACH #1 W/ ENCRYPTION - OLS



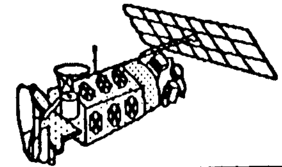
- ALL CLOCKS TO ENCRYPTERS ARE PROVIDED BY THE OSU TO PREVENT THE MODULATION OF CLEAR DATA ONTO ENCRYPTED DATA
- ONLY AVAILABLE 66.5 KHZ CLOCK IS ON SAME TEST CONNECTOR AS THE DATA
- WEC IS INVESTIGATING WHETHER OR NOT THIS CLOCK MEETS ENCRYPTION REQUIREMENTS
  - WEC WILL PERFORM MEASUREMENTS TO DETERMINE IF THE CLOCK IS MODULATED BY THE DATA USING THE BENCH TEST MODEL WHEN AVAILABLE
- IF CLOCK MEETS REQUIREMENTS RDS COULD BE ENCRYPTED IN THE THIS APPROACH WITH ONLY THE ADDITION OF A NEW ENCRYPTER AND CABLES
- THE OLS CURRENTLY HAS CONTROL LINES FOR A FOURTH ENCRYPTER
- ENCRYPTED DATA WOULD BE AVAILABLE ONLY FROM FORMATTER-G, CLEAR ONLY FROM FORMATTER-H

SPS connectors have separate outputs for clear

S-BAND APPROACH #1 WITH ENCRYPTION

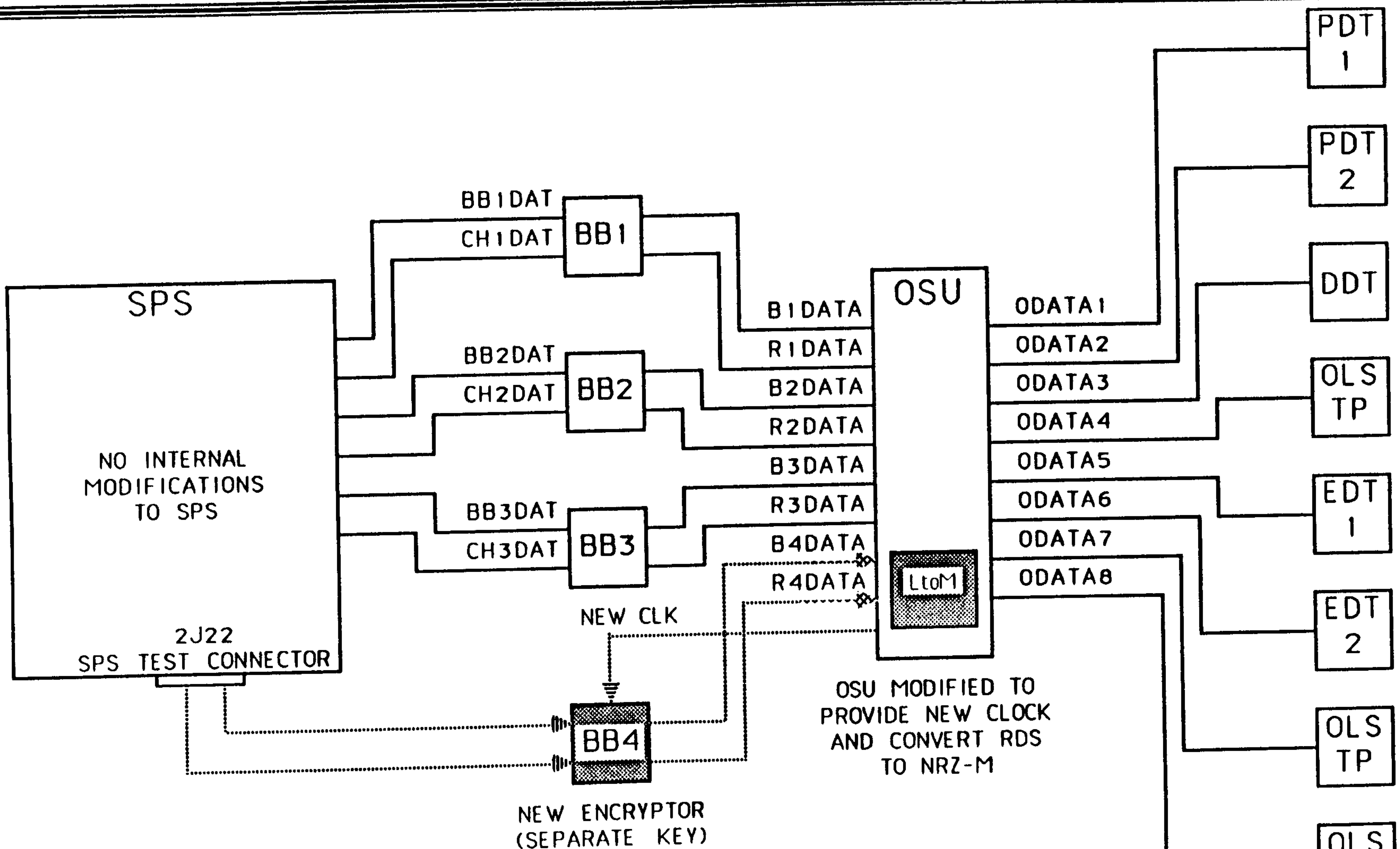


S-BAND APPROACH #2 - OLS

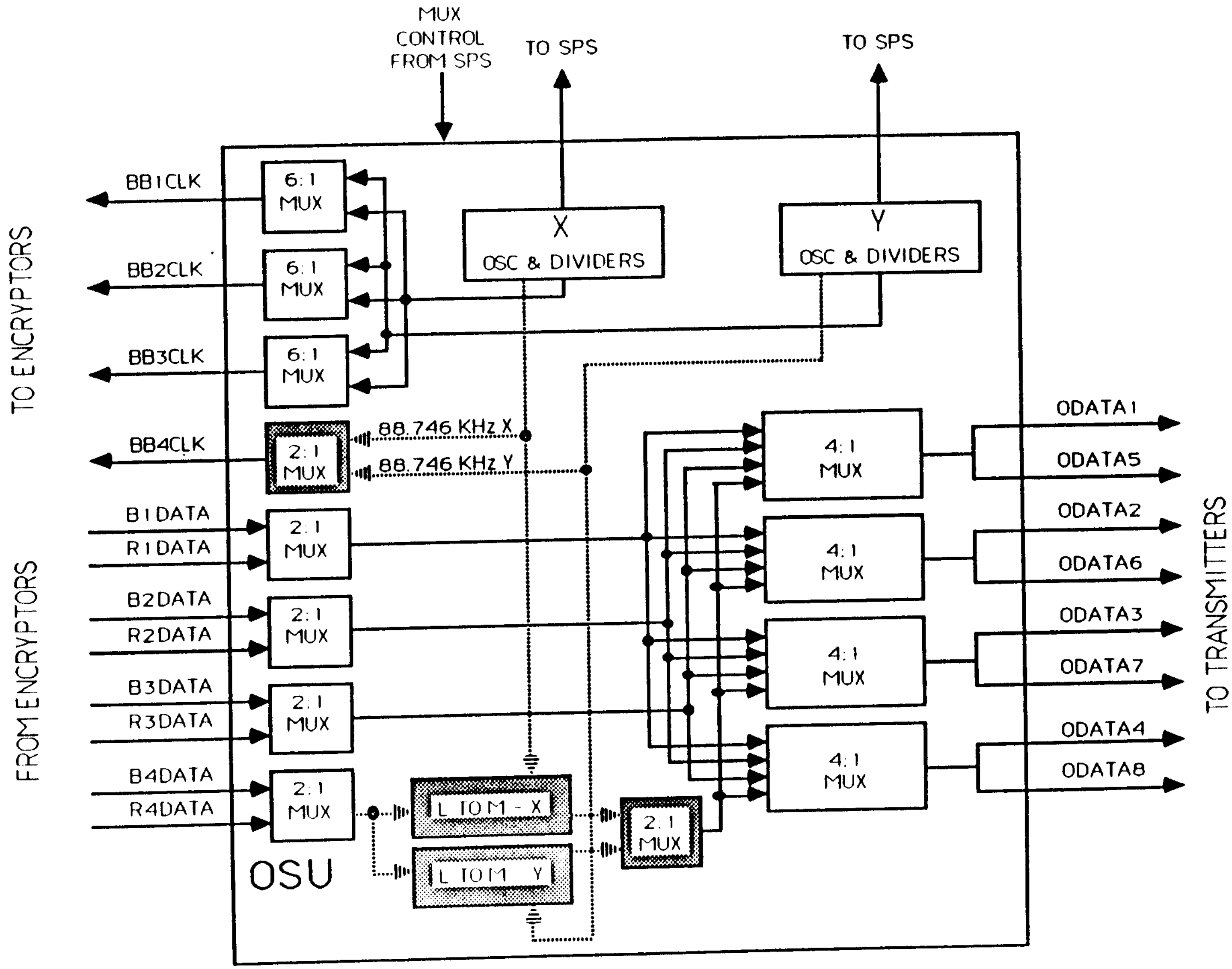


- THE S-BAND APPROACH #2 ONLY REQUIRES MODIFICATIONS TO THE OSU
  - SMOOTH DATA FROM THE G AND H FORMATTERS ARE AVAILABLE ON A TEST CONNECTOR USED FOR GROUND TESTING
  - IN OPERATION SDS-G AND SDS-H WOULD BE ATTACHED TO BB4DAT AND CH4DAT ON A NEW KG-43 ENCRYPTER, AND THE ENCRYPTER CONNECTED TO B4DATA AND R4DATA ON THE MODIFIED OSU
  - THE OSU WOULD CONVERT NRZ-L ENCRYPTED OR CLEAR RDS DATA TO NRZ-M, ROUTE THE SMOOTH DATA TO THE APPROPRIATE TRANSMITTER AND PROVIDE A CLEAN UNMODULATED CLOCK TO THE NEW ENCRYPTER
  - THE OLS CURRENTLY HAS CONTROL LINES FOR A FOURTH ENCRYPTER
  - ENCRYPTED DATA WOULD BE AVAILABLE ONLY FROM FORMATTER-G, CLEAR, ONLY FROM FORMATTER H

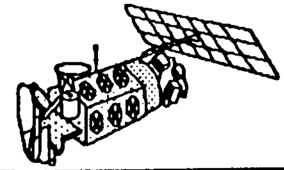
S-BAND APPROACH #2 - OLS



S-BAND APPROACH #2 - OLS

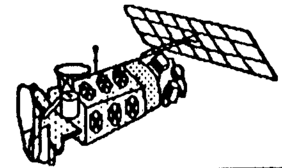


S-BAND APPROACHES #1 & #2/ SPACECRAFT COMMUNICATIONS



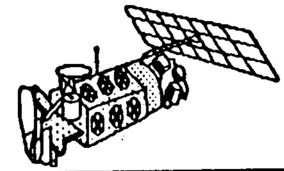
- Communications scheme same for unencrypted and encrypted approaches
- No modifications to present spacecraft communications hardware are needed
- ETM testing has demonstrated compatibility of existing transmitter design with RDS data rate (66.56 or 88.746 kbps)
- Only change is in functional usage of dedicated transmitter. Capability exists for transmission of both RDS and OLS recorded data on a time-sharing basis
- A dedicated transmitter was chosen (PDT-2) for simplification of ground receive equipment

S-BAND APPROACHES #1 & #2/ SPACECRAFT COMMUNICATIONS



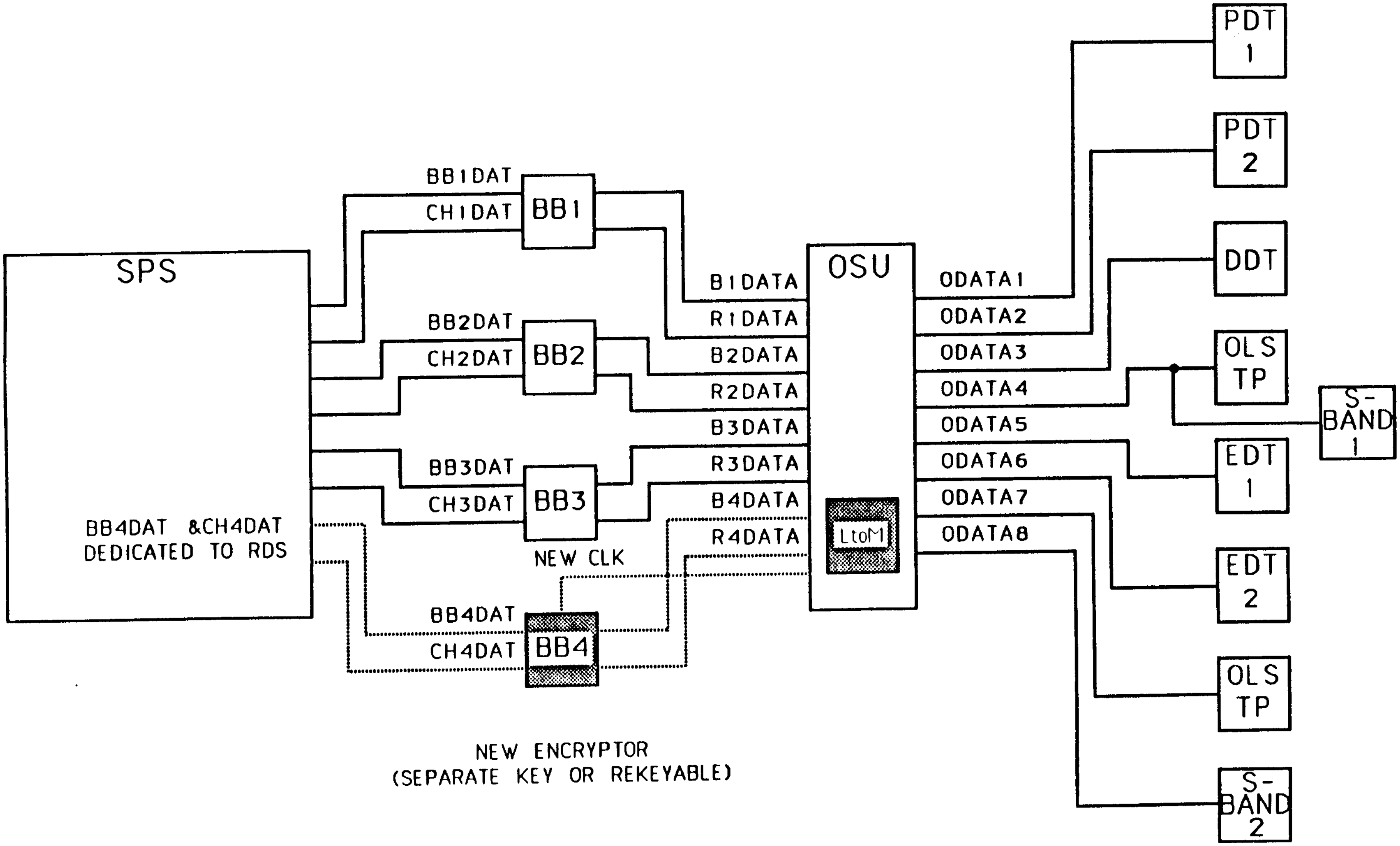
- PDT-2 chosen because its use incurs the least amount of conflict with the present operational system
  - EDT's: Use of an EDT would prevent simultaneous transmission of real-time telemetry
  - DDT: Use of the DDT would prevent simultaneous transmission of RTD at 1.024 MHz (used by tactical terminals)
  - PDT-1: Presently used more often than PDT - 2

S-BAND APPROACH #3 - OVERVIEW

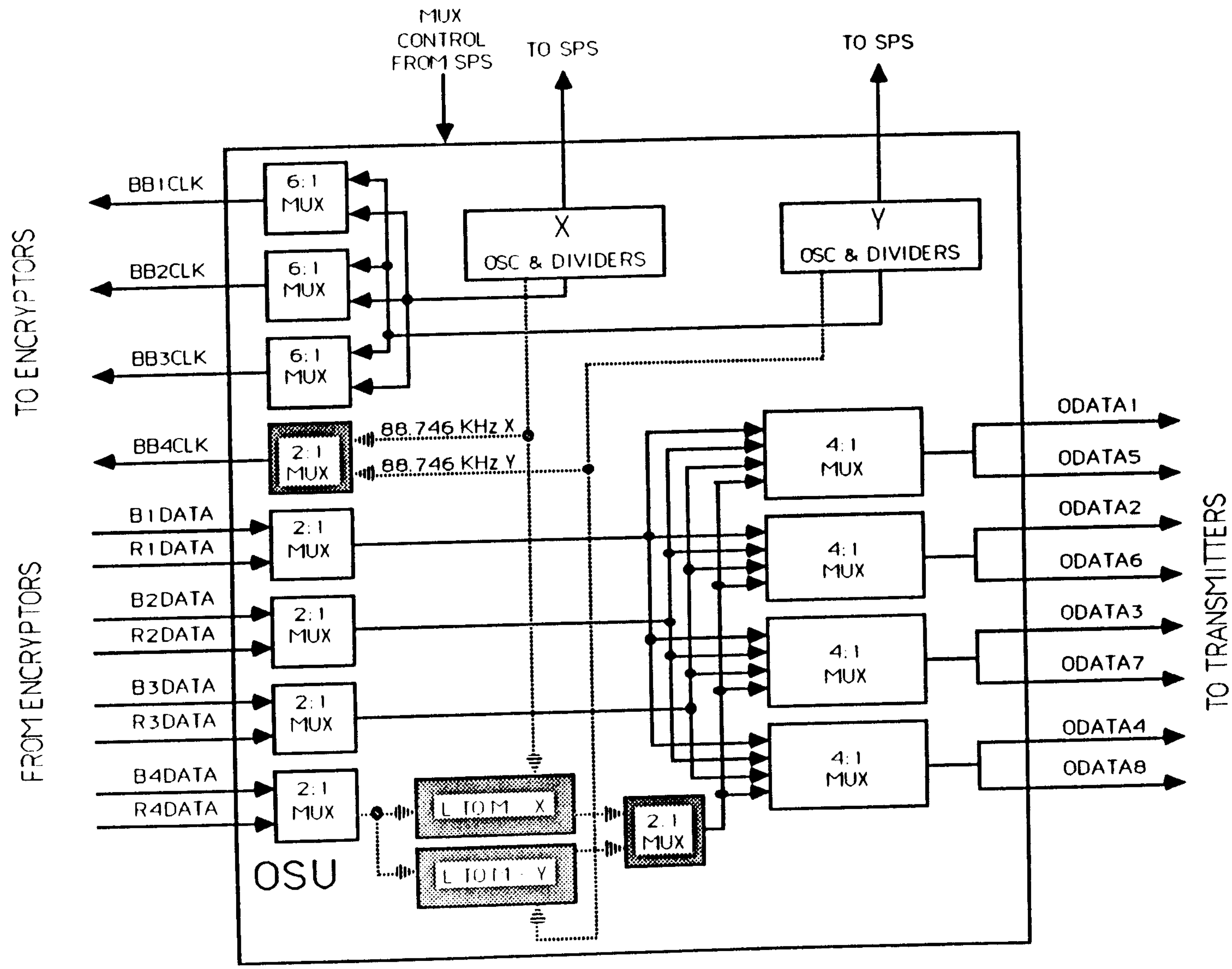


- THE IMPACT OF APPROACH #3 ON THE OLS IS ESSENTIALLY THE SAME AS THAT OF THE VHF/UHF DIGITAL APPROACH WHICH WILL BE DISCUSSED IN THE NEXT SECTION OF THE BRIEFING
- SPS MUST BE MODIFIED TO ROUTE MULTIPLEXED RDS TO A NEW ENCRYPTER
- OSU MUST BE MODIFIED TO
  - PROVIDE NEW CLOCK TO ENCRYPTER
  - CONVERT NRZ-L DATA FROM ENCRYPTER TO NRZ-M
  - ROUTE NEW DATA TO MULTIPLEXERS
- ENCRYPTED NRZ-M REAL-TIME DATA SMOOTH WILL BE AVAILABLE TO ANY EXISTING OR NEW TRANSMITTER CONNECTED TO THE OSU
- IN APPROACH #3 RDS IS EQUIVALENT TO PRIMARY DATA STREAMS IN BOTH REDUNDANCY AND CHOICE OF ROUTING TO TRANSMITTERS

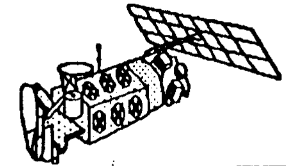
S-BAND APPROACH #3 - OVERVIEW

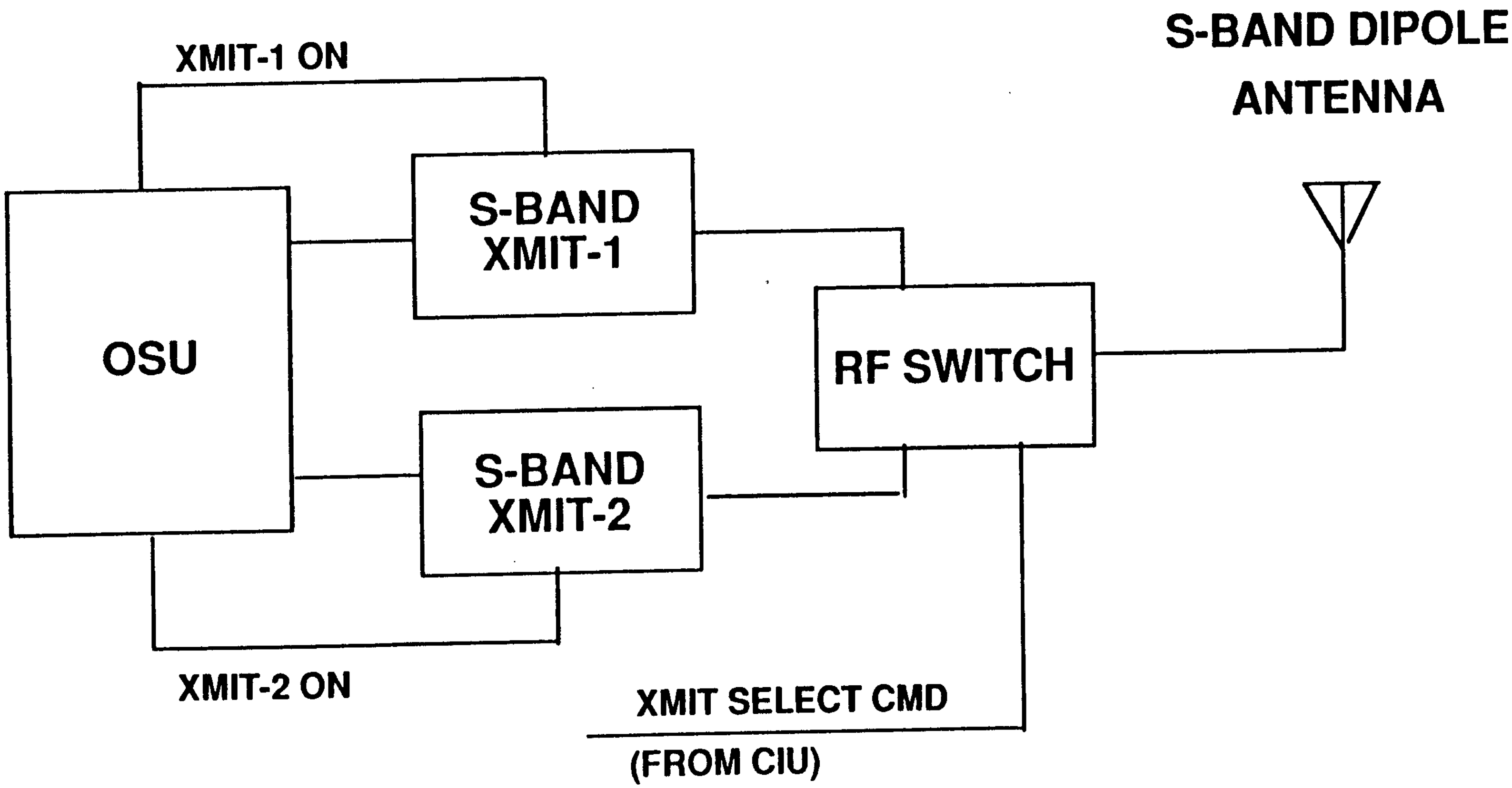


S-BAND APPROACH #3 - OLS OSU

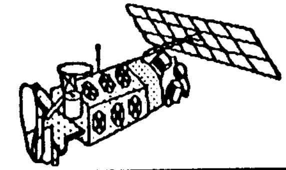


S-BAND APPROACH #3- SPACECRAFT COMMUNICATIONS





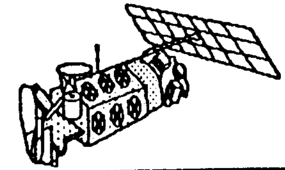
S-BAND APPROACH #3-
SPACECRAFT COMMUNICATIONS



- Transmitters -
  - Present transmitter design can be used over entire 2200-2300 band with tuning to optimize performance at chosen carrier frequency

- RF switch -
  - Use RF switch presently used by TIROS , purchased from vendor
  - Insertion loss less than 0.2 dB

- Antenna
  - Present antenna design can be used over entire 2200-2300 MHz band with tuning to optimize performance at chosen carrier frequency



S-BAND LINK
POWER/WEIGHT ESTIMATES FOR NEW UNITS

Peak

- **Approach # 1 with Encryption and Approach # 2:**

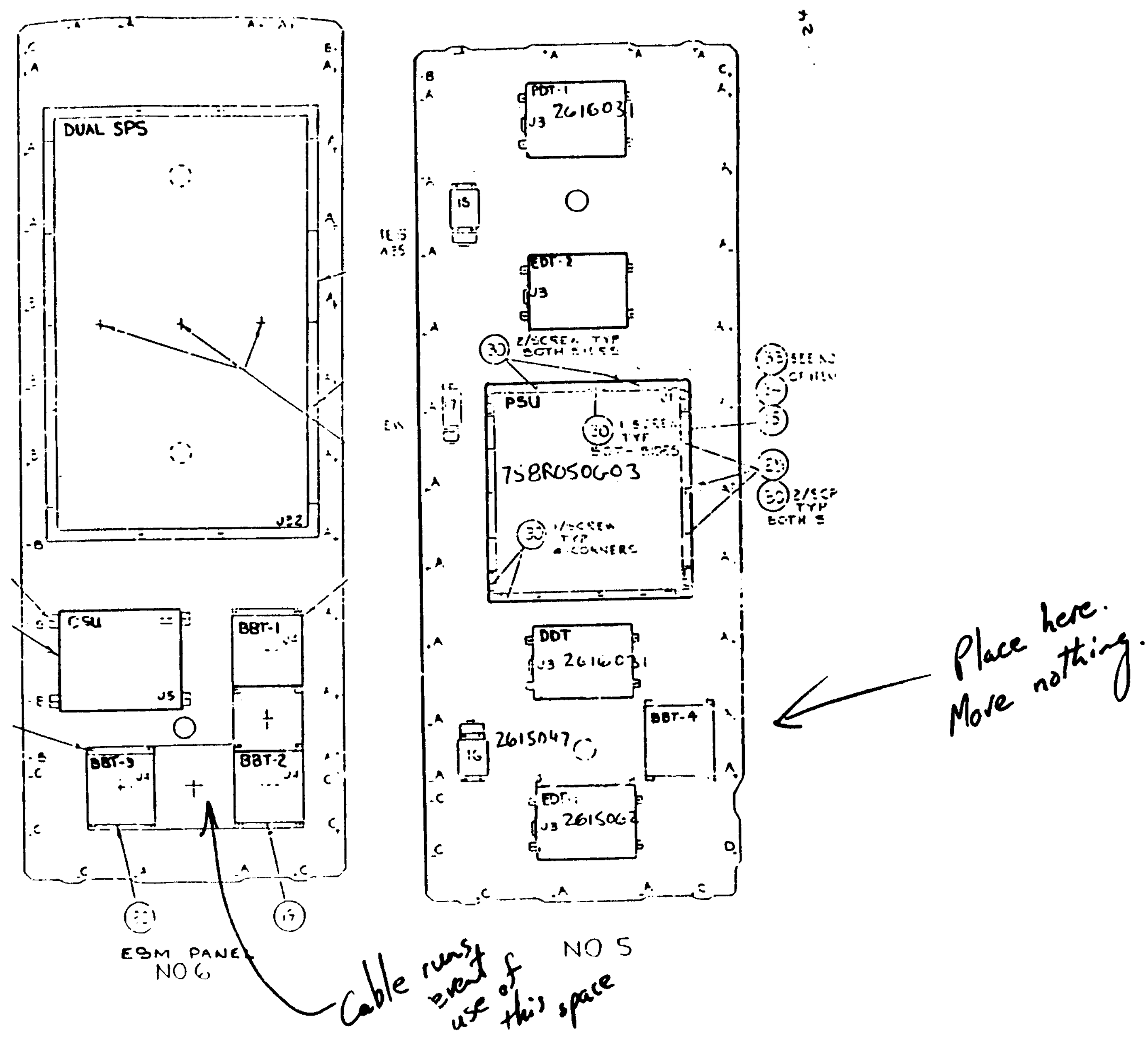
EQUIPMENT	POWER (watts)	WEIGHT (lbs)
Crypto BBT4	10.0	3.7

- **Approach # 3:**

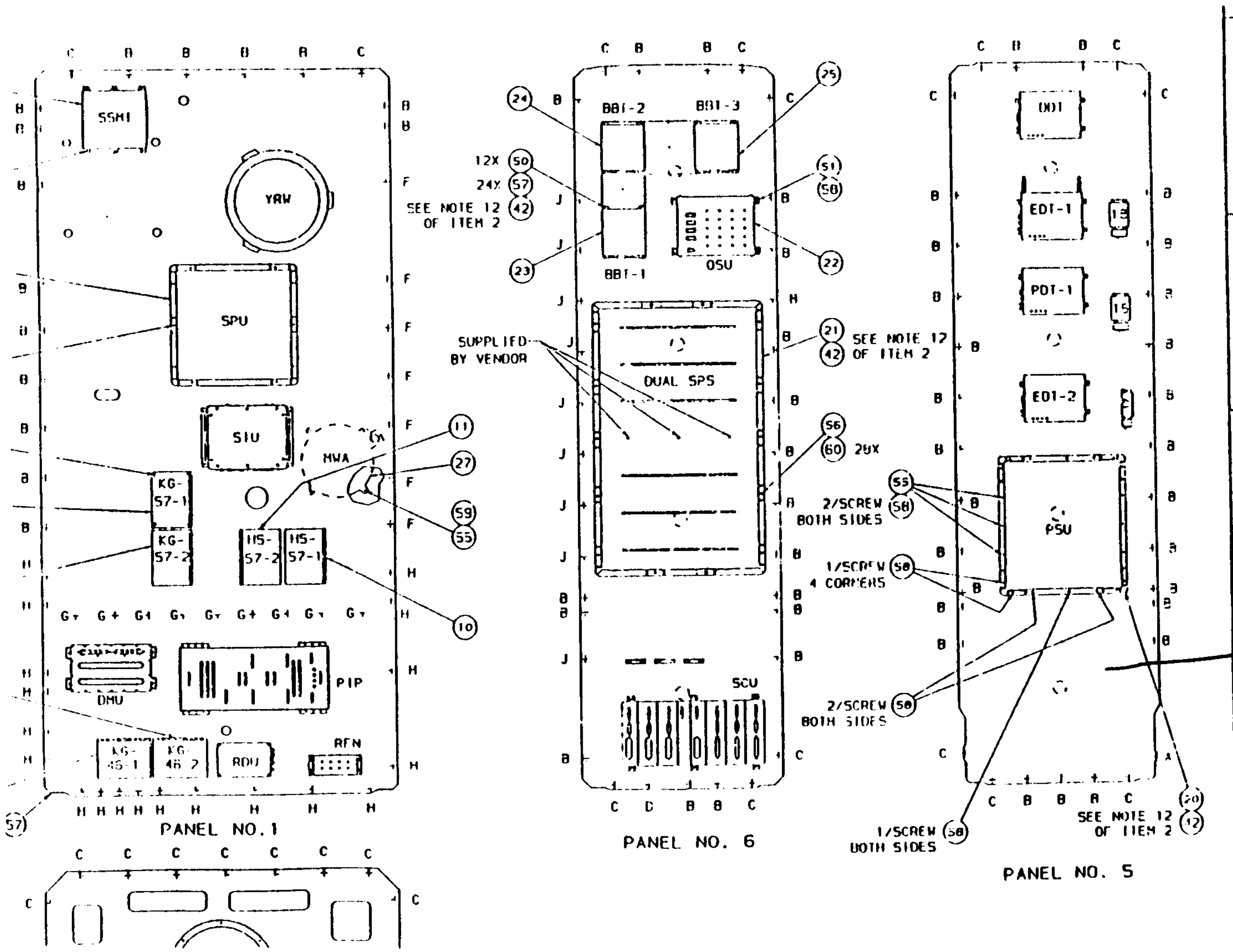
EQUIPMENT	POWER (watts)	WEIGHT (lbs)
New S-Band Xmit 1	27.0	2.2
New S-Band Xmit 2	27.0	2.2
Crypto BBT4	10.0	3.7
RF Switch	1.0	0.2
RF Antenna	...	0.65
Cabling	...	1.0
Total	38.0	9.95

Only 1 at a time

PRELIMINARY LAYOUT OF BBT4
(Approach # 1 w/ Encryption and Approach # 2)

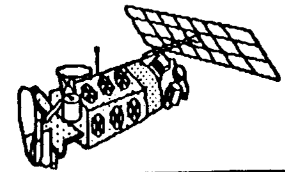


PRELIMINARY LAYOUT OF NEW EQUIPMENT
(S-BAND APPROACH # 3)



New TX.'s in this area.

S-BAND APPROACH # 3
NEW TELEMETRY & COMMAND SIGNALS



TELEMETRY	COMMAND
- Xmit 1 out power (A)	OLS Commands:
- Xmit 2 out Power (A)	Xmit 1 On
- Xmit 1Temp (A)	Xmit 2 on
- Xmit 2 Temp (A)	CIU Command:
- Xmit 1 On/Off (D)	Xmit Select
- Xmit 2 On/Off (D)	

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S-BAND DIGITAL APPROACH EVALUATION CRITERIA

- SATELLITE COMPLEXITY
- RECEIVING SYSTEM COMPLEXITY
- AVAILABILITY OF MISSION SENSOR DATA
- FEASIBILITY OF ENCRYPTION
- RESOLUTION OF IMAGERY
- DIFFICULTY OF OBTAINING FREQUENCY ALLOCATION
- SUSCEPTIBILITY TO RADIO FREQUENCY INTERFERENCE (RFI)
- SUSCEPTIBILITY TO JAMMING

NOTE: THE SAME EVALUATION CRITERIA ARE USED FOR ALL APPROACHES

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REALTIME DATA SMOOTH (RDS) LINK BUDGET SUMMARY

CASE	REQUIRED RECEIVING ANTENNA GAIN	RECEIVING ANTENNA SIZE
1. 2237.5 MHz, SPACECRAFT OMNI ANT, 1.024 MHz SUBCARRIER	25.1 dB	4.0 FEET
2. 2237.5 MHz, SPACECRAFT DIRECTIONAL ANT, 1.024 MHz SUBCARRIER	18.3 dB	1.8 FEET
3. 2267.5 MHz, SPACECRAFT DIRECTIONAL ANT, DIRECT MODULATION	15.4 dB	1.3 FEET
4. 137.5 MHz, TIROS ANTENNA, DIRECT MODULATION, CONVOLUTIONAL CODING	-3.7 dB	OMNI
5. 225 MHz, TIROS-LIKE ANTENNA, DIRECT MODULATION, CONVOLUTIONAL CODING	-3.4 dB	OMNI

PDT-2

2' we std size.

NOTE THAT THE S-BAND APPROACHES ALL REQUIRE DIRECTIONAL (STEERABLE) RECEIVING ANTENNAS

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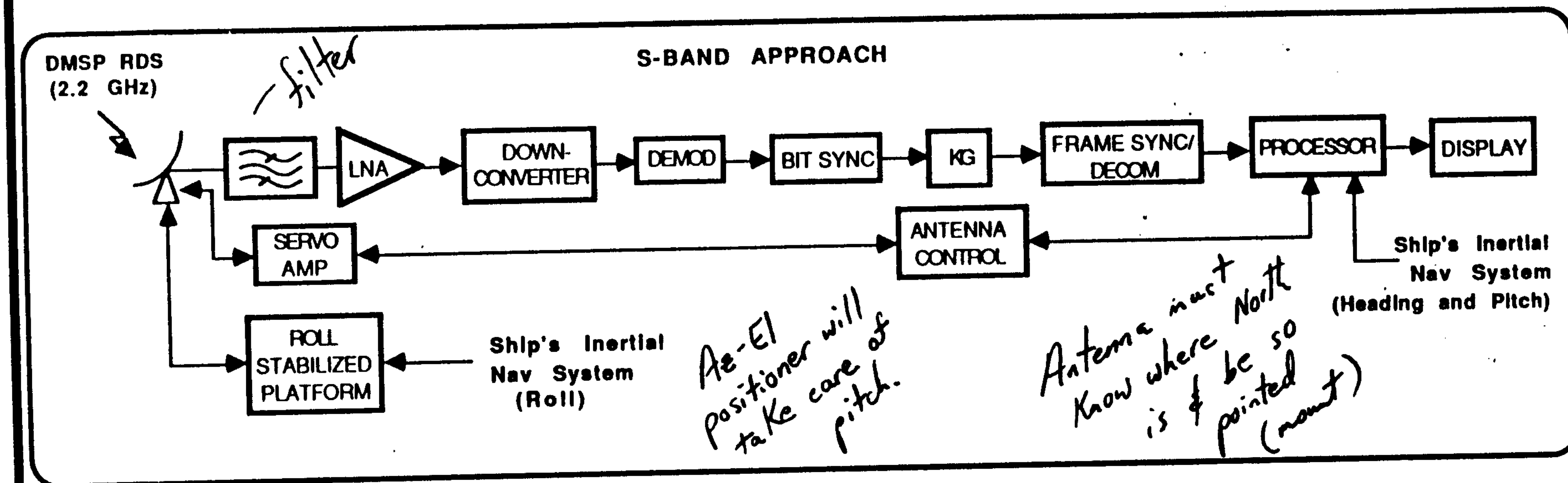
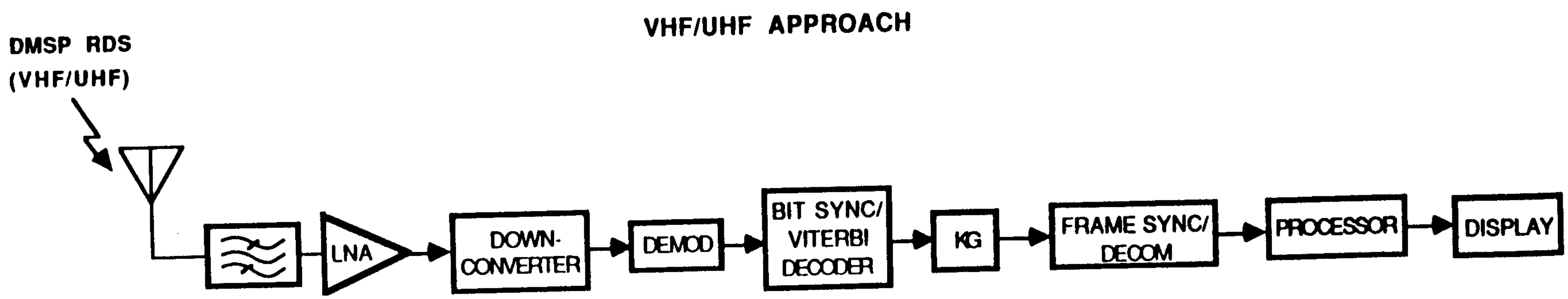
GENERALIZED BLOCK DIAGRAM FOR SHIPBOARD RDS RECEIVING SYSTEMS





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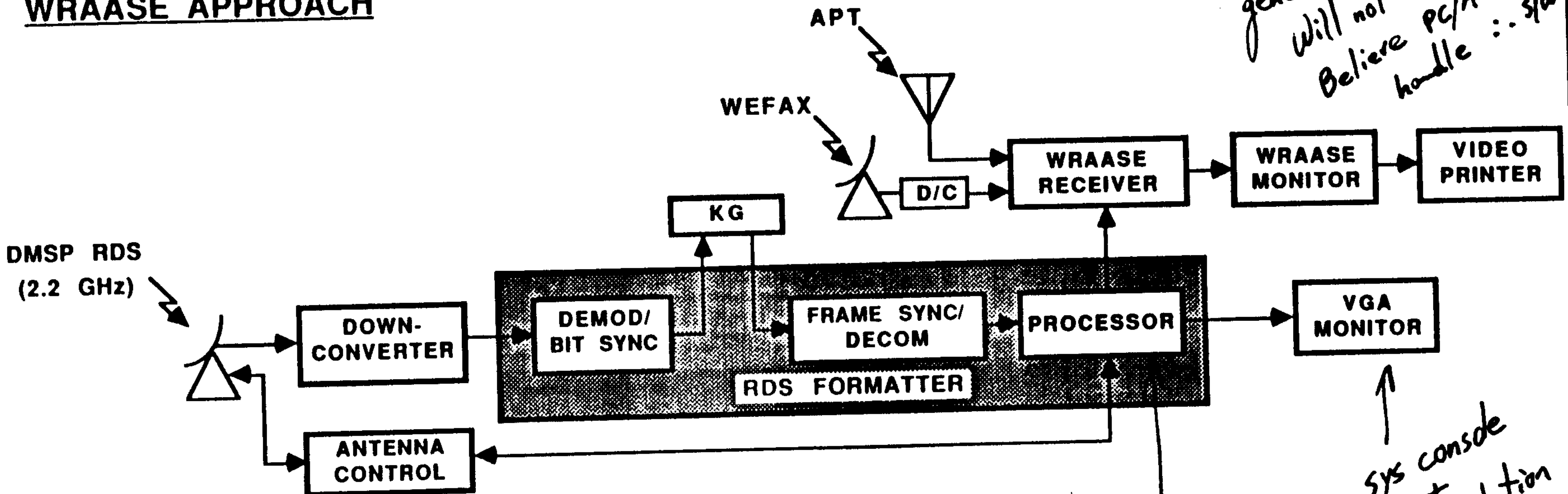
S-BAND DIGITAL APPROACHES FOR RDS RECEPTION

Note: Not currently "considering" MS product generation. (Will store data) Will not cost it in. Believe PC/AT will handle ∴ s/w cost is I

WRAASE APPROACH



PC/AT Tempest version.

sys console + full resolution data

- LANDBASED VERSIONS SHOWN. SHIPBOARD SYSTEMS ALSO REQUIRE HEADING, PITCH, AND ROLL STABILIZATION
- NO PROVISIONS ARE MADE FOR POINTING THE WEFAX ANTENNA ABOARD SHIP

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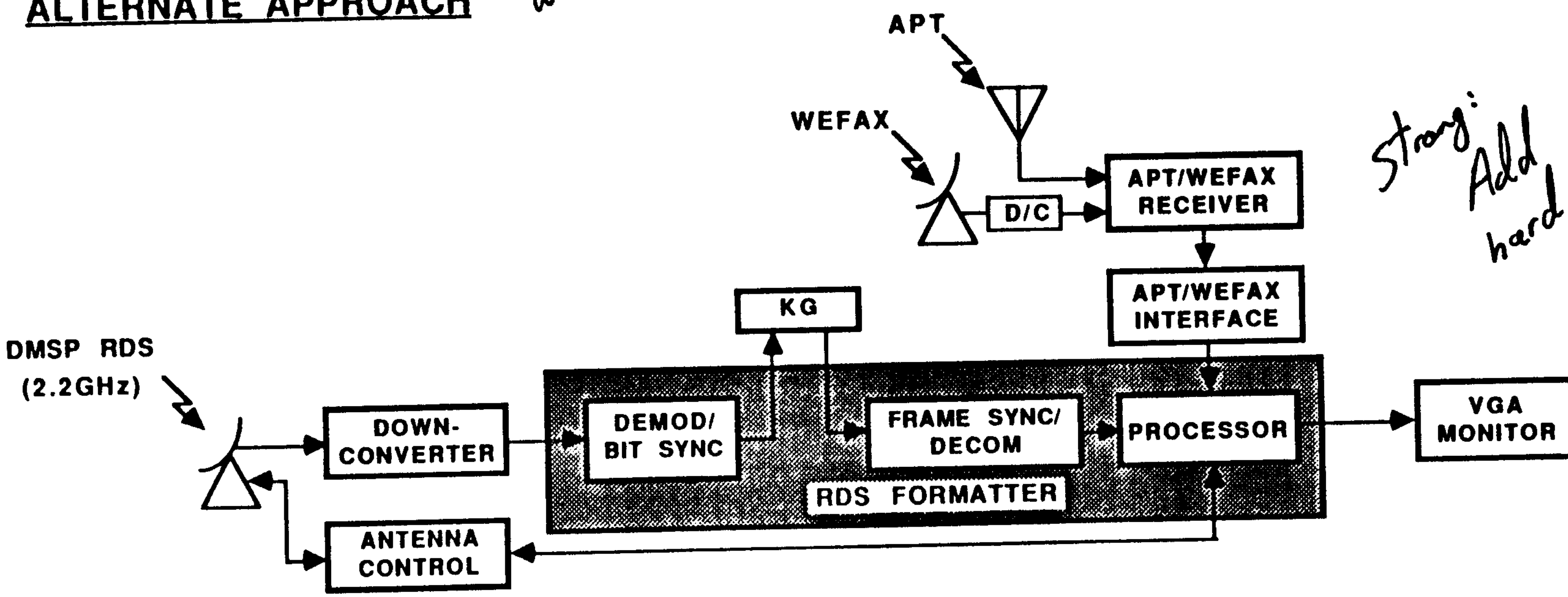
S-BAND DIGITAL APPROACHES FOR RDS RECEPTION

ALTERNATE APPROACH

Not using WRAASE



- LANDBASED VERSIONS SHOWN. SHIPBOARD SYSTEMS ALSO REQUIRE HEADING, PITCH, AND ROLL STABILIZATION
- NO PROVISIONS ARE MADE FOR POINTING THE WEFAX ANTENNA ABOARD SHIP

ie. No WEFAX on board ship. Too hard.

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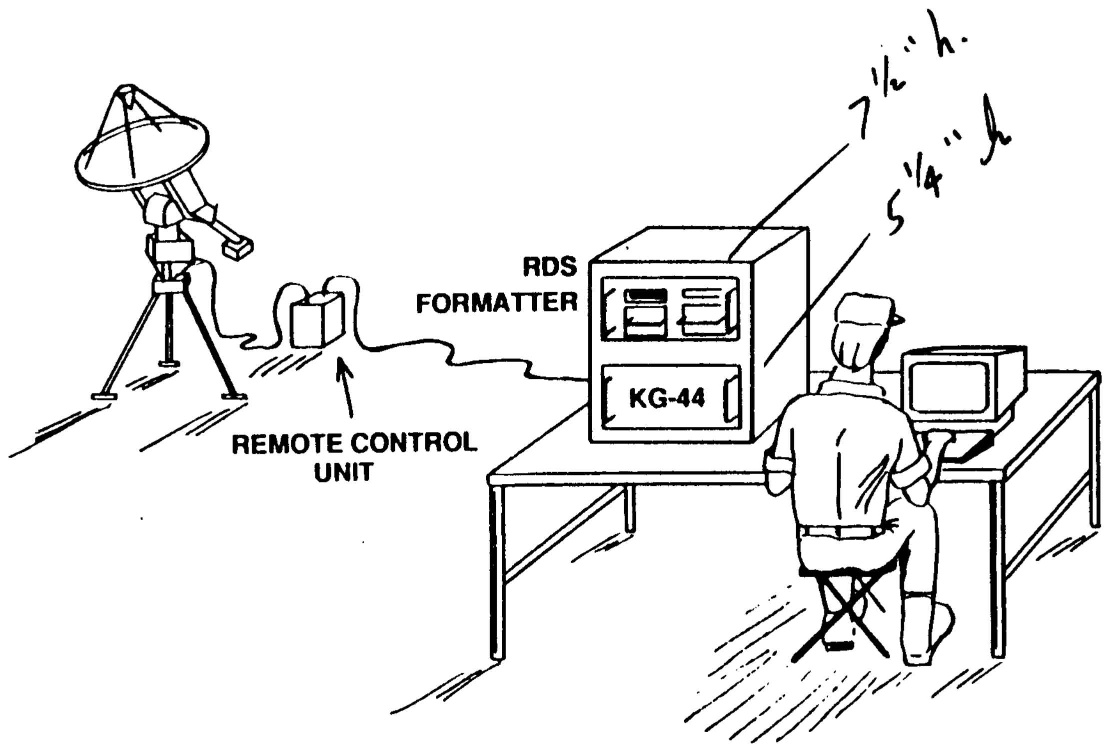
RDS RECEIVING SYSTEM LAYOUT (ARTIST'S CONCEPT)



Note: w/o WRAASE or WEFAX/APT.

Weight ≈ 200 #

44's for short term.
Could go to Ricebird

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FUNCTIONS OF RDS FORMATTER

- **DEMOD/BIT SYNC**
  - RECEIVES 70 MHZ IF SIGNAL FROM DOWNCONVERTER
  - TRACKS DOPPLER SHIFT ON RDS SIGNAL
  - DEMODULATES SIGNAL WITH COSTAS LOOP DEMOD
  - RECOVERS DATA AND CLOCK WITH BIT SYNCHRONIZER
- **FRAME SYNC/DECOM**
  - DEINTERLEAVES VISUAL AND THERMAL DATA
  - DETECTS FRAME SYNC, LINE SYNC, AND LINE SUB-SYNC PATTERNS
  - CONVERTS DATA TO PARALLEL WORDS
  - PERFORMS EARTH CURVATURE CORRECTION
  - BUFFERS DATA FOR DMA INTO MEMORY
- **PROCESSOR**
  - MANAGES DATA STORAGE, RETRIEVAL, AND DISPLAY
  - CONTROLS DEMOD/BIT SYNC AND FRAME SYNC/DECOM
  - PERFORMS GRIDDING CALCULATIONS
  - ACCEPTS OPERATOR INPUT OF NORAD TWO-CARD EPHEMERIS DATA SETS
  - CALCULATES ANTENNA POINTING ANGLES
  - CONTROLS ANTENNA POSITION DURING PASS

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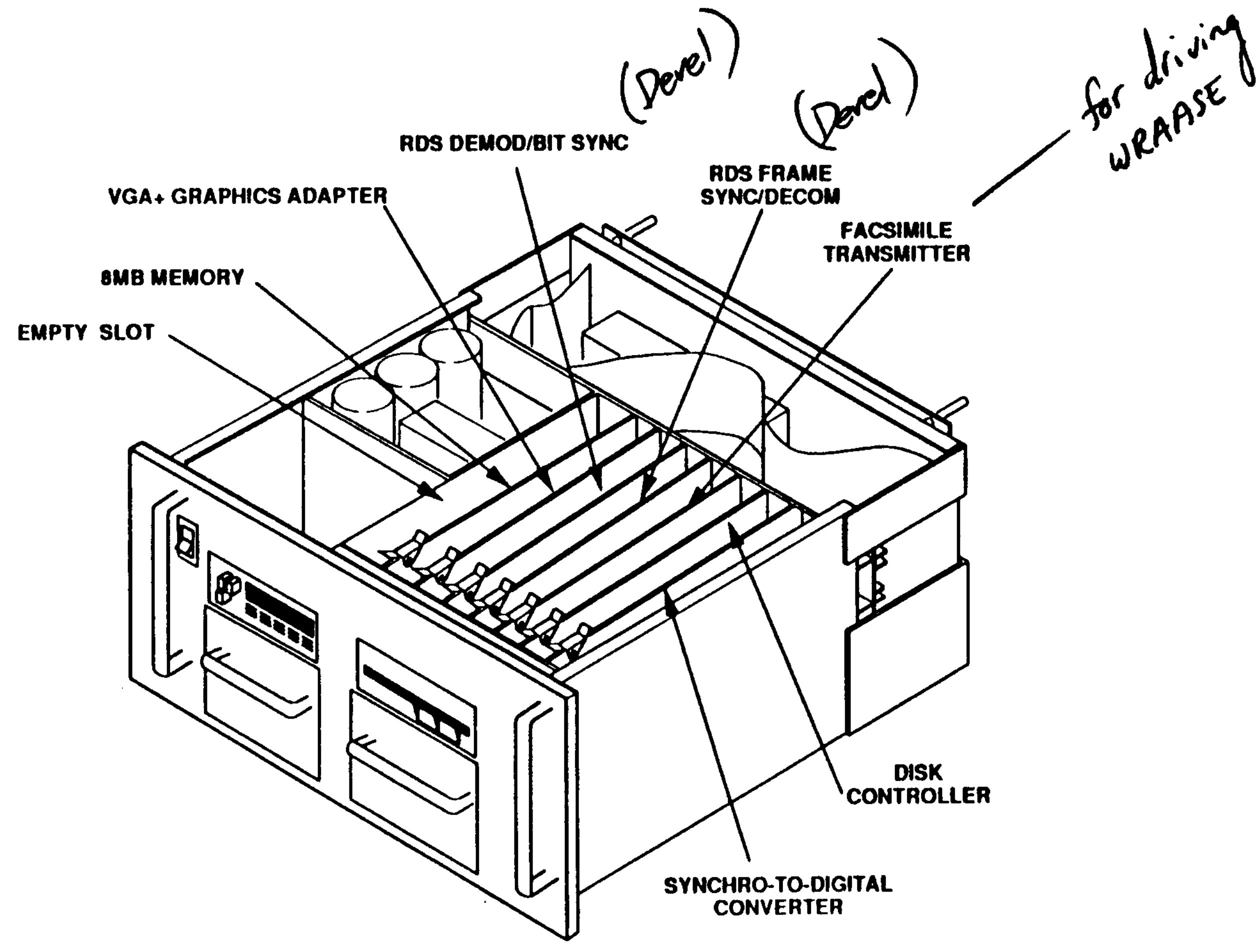
RDS FORMATTER LAYOUT (ARTIST'S CONCEPT)



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RDS FORMATTER CONFIGURATION FOR S-BAND AND VHF/UHF DIGITAL APPROACHES

	WRAASE APPROACH	ALTERNATE APPROACH
PC/AT-COMPATIBLE PROCESSOR WITH FLOATING POINT COPROCESSOR AND 20MB HARD DISK	X	X
8MB EMS MEMORY	X	X
VGA+ GRAPHICS ADAPTER	X	X
RDS DEMOD/BIT SYNC (NOTE 1)	X	X
RDS FRAME SYNC/DECOM	X	X
FACSIMILE TRANSMITTER	X	
APT/WEFAX ACQUISITION CARD		X
SYNCHRO-TO-DIGITAL CONVERTER (NOTE 2)	X	X

Looked at digital input to WRAA & chose analog (2 vs 10 wire, driv power, etc.

NOTE 1: BIT SYNC WILL HAVE VITERBI ERROR CORRECTION IN VHF/UHF APPROACHES

NOTE 2: SYNCHRO-TO-DIGITAL CONVERSION CARD REQUIRED ONLY IN SHIPBOARD S-BAND SYSTEMS or 80386

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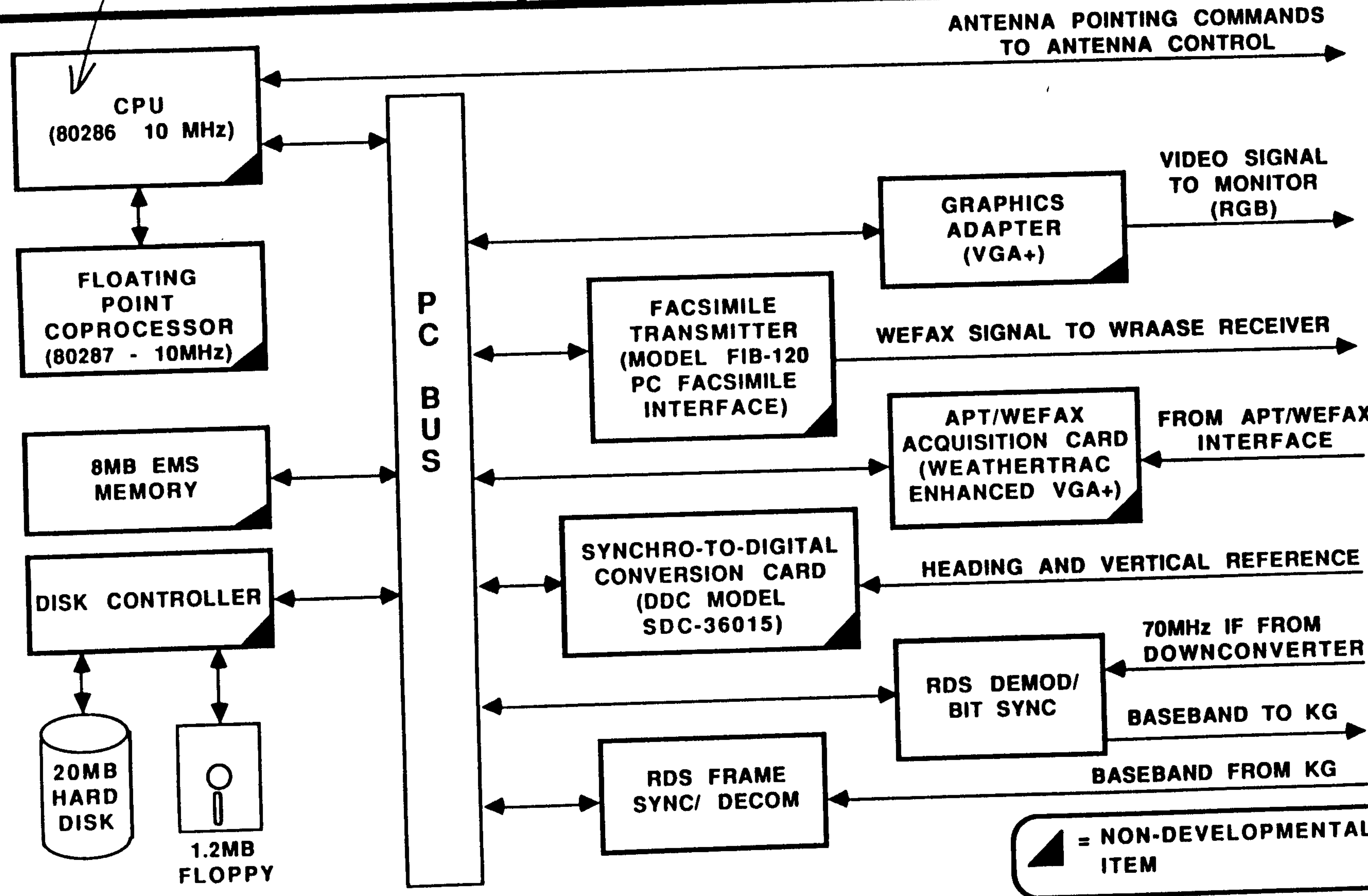
RDS FORMATTER BLOCK DIAGRAM



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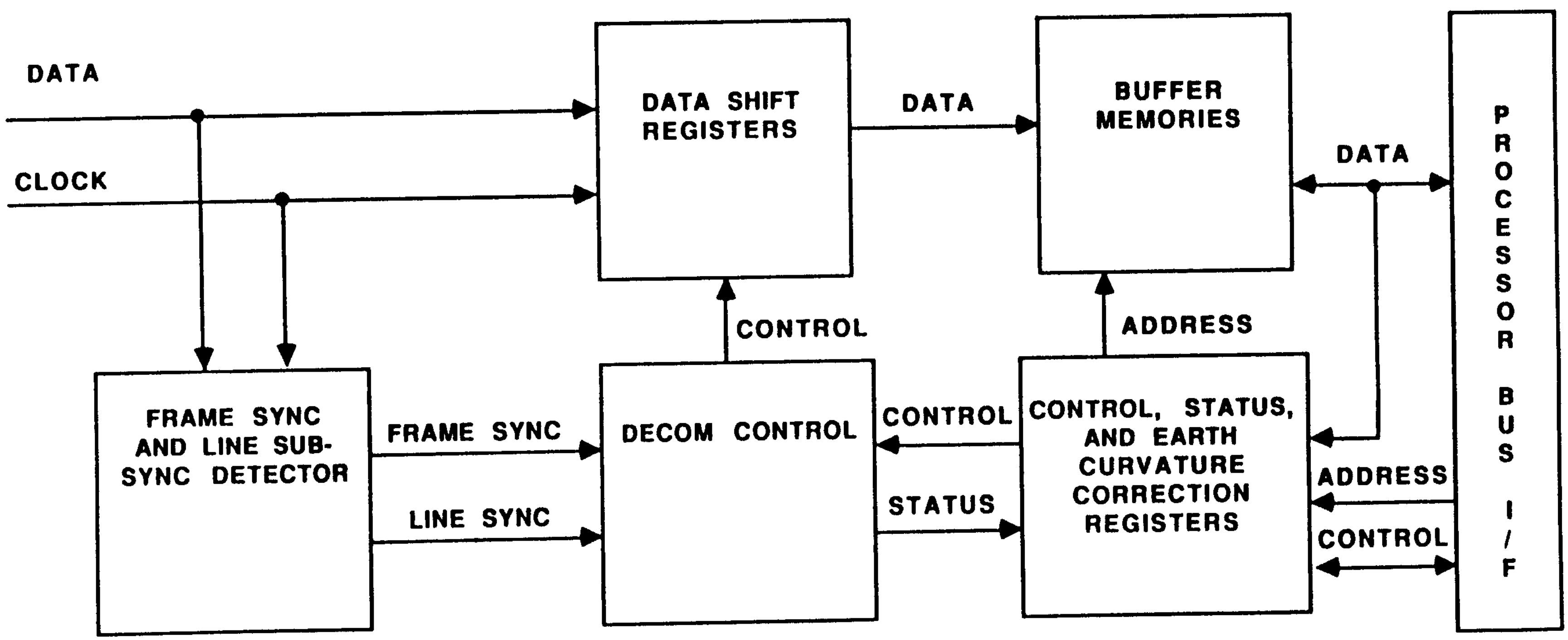
FRAME SYNC / DECOM CARD BLOCK DIAGRAM



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ANTENNA POINTING APPROACH

- DUE TO THE WIDE BEAMWIDTH OF THE ANTENNA, ONLY PROGRAM TRACKING IS REQUIRED.

- AS RECOMMENDED BY SPACE COMMAND, THE SYSTEM WILL UTILIZE THE NORAD SGP4 MODEL TO DETERMINE SATELLITE POSITION.

    -EPHEMERIS DATA SUPPLIED BY NORAD TWO-CARD ELEMENT SETS.

    -POSITION DATA TRANSMITTED BY THE SATELLITE WILL BE USED TO PSEUDO-AUTOTRACK FOR BETTER POINTING ACCURACY BETWEEN EPHEMERIS DATA UPDATES.

- POINTING ALGORITHM REQUIRES ACCURATE CURRENT TIME. THIS IS PROVIDED BY THE PROCESSOR'S INTERNAL CLOCK WHICH WILL BE AUTOMATICALLY UPDATED FROM THE SATELLITE'S CLOCK DURING EVERY TRACKED SATELLITE PASS.

- ON SHIPBOARD APPLICATIONS, THE PROCESSOR WILL OBTAIN SHIP'S ATTITUDE FROM THE SHIP'S INERTIAL NAVIGATION SYSTEM (SINS), IF AVAILABLE, OR FROM AN INDEPENDENT GYROCOMPASS AND VERTICAL GYRO IF SINS IS NOT AVAILABLE.

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ANTENNA POINTING CALCULATIONS

OBJECTIVE: CALCULATE POINTING ANGLES (AZIMUTH AND ELEVATION) TO THE SATELLITE WITH SUFFICIENT ACCURACY TO RECEIVE THE RDS TRANSMISSION.

METHOD: AT ONE SECOND INTERVALS:

1. PREDICT SATELLITE LOCATION IN AN EARTH-CENTERED NON-ROTATING COORDINATE SYSTEM USING THE SGP4 ORBITAL MODEL. THE SATELLITE'S POSITION IS PREDICTED FOR 0.5 SECONDS IN THE FUTURE.

2. CALCULATE CONVERSION MATRIX FROM EARTH-CENTERED TO ANTENNA COORDINATE SYSTEM.

3. SUBTRACT ANTENNA POSITION VECTOR FROM SATELLITE POSITION VECTOR, YIELDING ANTENNA LOOK VECTOR. MULTIPLY THE LOOK VECTOR BY THE CONVERSION MATRIX TO CONVERT TO ANTENNA COORDINATE SYSTEM.

4. CONVERT FROM X,Y,Z COORDINATES TO AZIMUTH AND ELEVATION ANGLES.

5. ADD IN ANTENNA AZIMUTH OFFSET AND OFFSETS COMPUTED FROM THE SHIP'S ATTITUDE SENSORS, IF APPLICABLE.

6. COMMAND ANTENNA TO NEW POSITION.

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EARTH CURVATURE CORRECTION

ACROSS-TRACK CORRECTION

OBJECTIVE: RESAMPLE RDS DATA TO ACHIEVE AN ACROSS-TRACK CONSTANT NOMINAL PIXEL SPACING. A NOMINAL PIXEL SPACING OF 1.25 NMI IS RECOMMENDED.

METHOD:

1. USING SCANLINE SUBPOINT DATA, CALCULATE THE DISTANCE FROM THE SUBPOINT OF EACH PIXEL IN THE SCANLINE.

2. CREATE RESAMPLED SCANLINE BY EXTRACTING PIXELS FROM THE ORIGINAL SCANLINE WHICH ARE CLOSEST TO 1.25 NMI SPACING.

ALONG-TRACK CORRECTION

OBJECTIVE: RESAMPLE RDS DATA TO ACHIEVE AN ALONG-TRACK CONSTANT NOMINAL SUBPOINT SPACING. A NOMINAL PIXEL SPACING OF 1.25 NMI IS RECOMMENDED

METHOD:

1. USING SCANLINE SUBPOINT DATA, CALCULATE THE DISTANCE BETWEEN THE SUBPOINTS OF EACH SCANLINE.

2. REPEAT SCANLINES AS REQUIRED TO CREATE AN AVERAGE OF ONE SCANLINE PER 1.25 NMI. THIS WILL REQUIRE REPEATING APPROXIMATELY EVERY FIFTH LINE.

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LATITUDE/LONGITUDE GRID OVERLAYS AND EARTH-LOCATION

- THE SYSTEM WILL AUTOMATICALLY PRODUCE LATITUDE / LONGITUDE GRID OVERLAYS.
- IT WILL ALSO BE POSSIBLE TO EARTH-LOCATE OBJECTS OF INTEREST IN THE IMAGE
- THE SATELLITE POSITION WILL BE DETERMINED USING THE LOCATION DATA CONTAINED IN THE RDS DATA STREAM.
- TO IMPROVE GRIDDING ACCURACY, EARTH WILL BE MODELED AS AN OBLATE SPHEROID WITH A POLAR RADIUS OF 6356.912 KM AND AN EQUATORIAL RADIUS OF 6378.388 KM.
- SINCE LOCATION DATA IS PROVIDED IN REAL-TIME BY THE SATELLITE, EXTREMELY ACCURATE CURRENT TIME DATA IS NOT REQUIRED.

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LOCATING SCANLINE SUBPOINT FOR GRIDDING AND EARTH-LOCATION

OBJECTIVE: DETERMINE SUBPOINT LATITUDE AND LONGITUDE AND SATELLITE ALTITUDE FOR EACH SCANLINE.

METHOD:

1. OBTAIN SUBPOINT SCAN TIME FROM RDS DATA STREAM.

2. USING THE SUBPOINT DATA PROVIDED EVERY TWO SECONDS IN THE RDS DATA STREAM, FIND THE SUBPOINT PROVIDED JUST PRIOR TO (POINT 1) AND JUST AFTER (POINT 2) THE TIME OF THE SUBPOINT SCAN.

3. CALCULATE THE AVERAGE ANOMALISTIC MOTION OF THE SATELLITE BETWEEN POINT 1 AND POINT 2. MULTIPLY THIS BY THE TIME INTERVAL BETWEEN POINT 1 AND THE SUBPOINT SCAN TIME.

4. CALCULATE THE SATELLITE'S POSITION WHEN THE SUBPOINT WAS SCANNED BY ADDING THE VALUE COMPUTED IN STEP 3 TO THE SATELLITE'S TRUE ANOMALY AT POINT 1.

5. PROJECT THE SATELLITE'S POSITION ON THE EARTH'S SURFACE TO FIND SUBPOINT. SUBTRACT EARTH'S RADIUS AT SUBPOINT FROM THE DISTANCE FROM THE CENTER OF THE EARTH TO THE SATELLITE TO FIND SATELLITE ALTITUDE.

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GRIDDING CALCULATIONS

OBJECTIVE: GIVEN A LATITUDE AND LONGITUDE, CALCULATE THE SCANLINE AND PIXEL NUMBER. THIS WILL BE USED FOR DRAWING LATITUDE-LONGITUDE GRIDLINES OVER THE IMAGE.

METHOD:

1. SEARCH FOR SCANLINE CONTAINING THE LATITUDE-LONGITUDE POINT. THIS IS ACCOMPLISHED USING A BINARY SEARCH TECHNIQUE WHICH REQUIRES A MAXIMUM OF TWELVE ITERATIONS. THE SCANLINE IS FOUND WHEN THE VECTOR FROM THE SCANLINE SUBPOINT TO THE LATITUDE-LONGITUDE POINT IS MOST NEARLY PERPENDICULAR TO THE INSTANTANEOUS SUBPOINT VELOCITY VECTOR.

2. COMPUTE THE DISTANCE BETWEEN THE SUBPOINT AND THE LATITUDE-LONGITUDE POINT. DIVIDE THIS BY 1.25 TO GET PIXEL NUMBER OFFSET FROM THE SUBPOINT PIXEL.

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EARTH-LOCATION CALCULATIONS

OBJECTIVE: GIVEN A SCANLINE AND PIXEL NUMBER, CALCULATE THE CORRESPONDING LATITUDE AND LONGITUDE. THIS WILL BE USED TO EARTH-LOCATE OBJECTS OF INTEREST IN THE IMAGE.

METHOD:

1. CALCULATE THE PIXEL NUMBER PRIOR TO EARTH CURVATURE CORRECTION RESAMPLING.

2. CALCULATE SCANNER ANGLE BASED ON PIXEL NUMBER CALCULATED IN STEP 1.

3. CALCULATE SATELLITE POSITION FROM SUBPOINT DATA.

4. CALCULATE THE POINT OF INTERSECTION OF SCANNER'S DIRECTION OF VIEW AND THE SURFACE OF THE EARTH.

5. CONVERT POINT OF INTERSECTION FROM X,Y,Z COORDINATES TO LATITUDE AND LONGITUDE

RESULTS OF ANTENNA INVESTIGATION

AT TIM 1, WE WERE ASKED TO CONSIDER USE OF PHASED ARRAY OR PLANAR ARRAY ANTENNAS-- OUR CONCLUSION IS THAT A CONVENTIONAL DISH ANTENNA IS THE MOST COST-EFFECTIVE SOLUTION:

PHASED ARRAYS:

-PHASED ARRAYS ARE VERY EXPENSIVE (10X-100X) IN COMPARISON WITH CONVENTIONAL ANTENNAS OF THE SAME GAIN, AND ARE USUALLY RESERVED FOR SPECIAL CIRCUMSTANCES:

-TRACKING MULTIPLE TARGETS
-TRACKING VERY-HIGHLY-DYNAMIC TARGETS
-NULL STEERING TO DEFEAT JAMMERS
-CLANDESTINE INSTALLATIONS (SIDE OF A TRUCK OR BUILDING)
-CONFORMAL INSTALLATIONS (AIRCRAFT SKINS)

-A PHASED ARRAY TO TRACK A POLAR ORBITING SATELLITE WOULD REQUIRE AT LEAST 4 ARRAY SURFACES, ARRANGED IN A TRUNCATED PYRAMID SHAPE

PLANAR ARRAYS:

-PLANAR ARRAYS DO PROVIDE THE MAXIMUM GAIN FOR A GIVEN SURFACE AREA, HOWEVER:

-PLANAR ARRAY SIDELOBE PERFORMANCE SUFFERS UNLESS COMPENSATED FOR IN THE DESIGN

-PLANAR ARRAYS STILL MUST BE POINTED MECHANICALLY AT THE TARGET

-A PLANAR ARRAY FOR RDS WOULD BE A FULL-CUSTOM DESIGN, COSTING MORE THAN A CONVENTIONAL DISH ANTENNA

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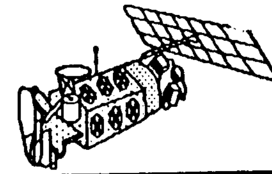
PROS AND CONS OF S-BAND DIGITAL APPROACH

ADVANTAGES:

- MINIMAL SATELLITE MODIFICATIONS
- FASTEST ROUTE TO DEMONSTRATION SYSTEM
- MISSION SENSOR DATA TRANSMITTED
- ENCRYPTION IS POSSIBLE
- FULL RDS RESOLUTION
- FREQUENCY ALLOCATION NOT DIFFICULT
- LESS SUSCEPTIBLE TO RFI AND JAMMING (DIRECTIONAL RCV ANTENNA)

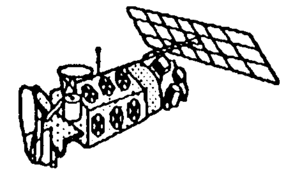
DISADVANTAGES:

- REQUIRES STEERABLE ANTENNA IN RECEIVING SYSTEM
  - RECEIVING SYSTEM RELATIVELY COMPLEX
  - SHIPBOARD RECEPTION REQUIRES PITCH, ROLL, AND HEADING STABILIZATION



VHF/UHF DIGITAL APPROACHES FOR DMSP REALTIME DATA SMOOTH

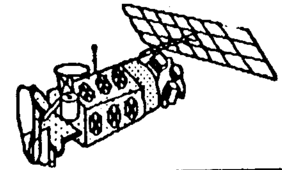
VHF/UHF DIGITAL APPROACH / OVERVIEW



- VHF / UHF digital approach
  - Lower frequency: Allows link closure with omnidirectional antenna on ground
  - Biphase Shift Keying (BPSK): Industry-standard modulation format
  - NRZ-M data format: Prevents problems with modulation sense detection
  - Convolutional coding: Adds 5 dB coding gain to link

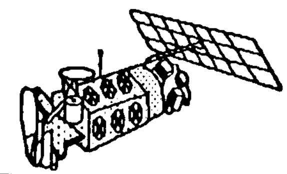
Could add to S-band to gain 5 db advantage for A-J. Not addressed previously because not needed for link closure.

VHF/UHF DIGITAL APPROACH - OVERVIEW



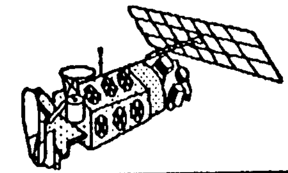
- VHF Digital Hardware
  - Dedicate fourth data channel in SPS (presently unused) to RDS
  - Add new encrypter (BBT4) with a separate key or dynamic rekeying capability
  - Modify OSU to include a convolutional rate 1/2 encoder and an NRZ-L to NRZ-M data converter. Dedicate data outputs four and eight of OSU (presently unused) to RDS
  - Route NRZ-M data to a redundant pair of new VHF/UHF transmitters and modified-TIROS-design antenna

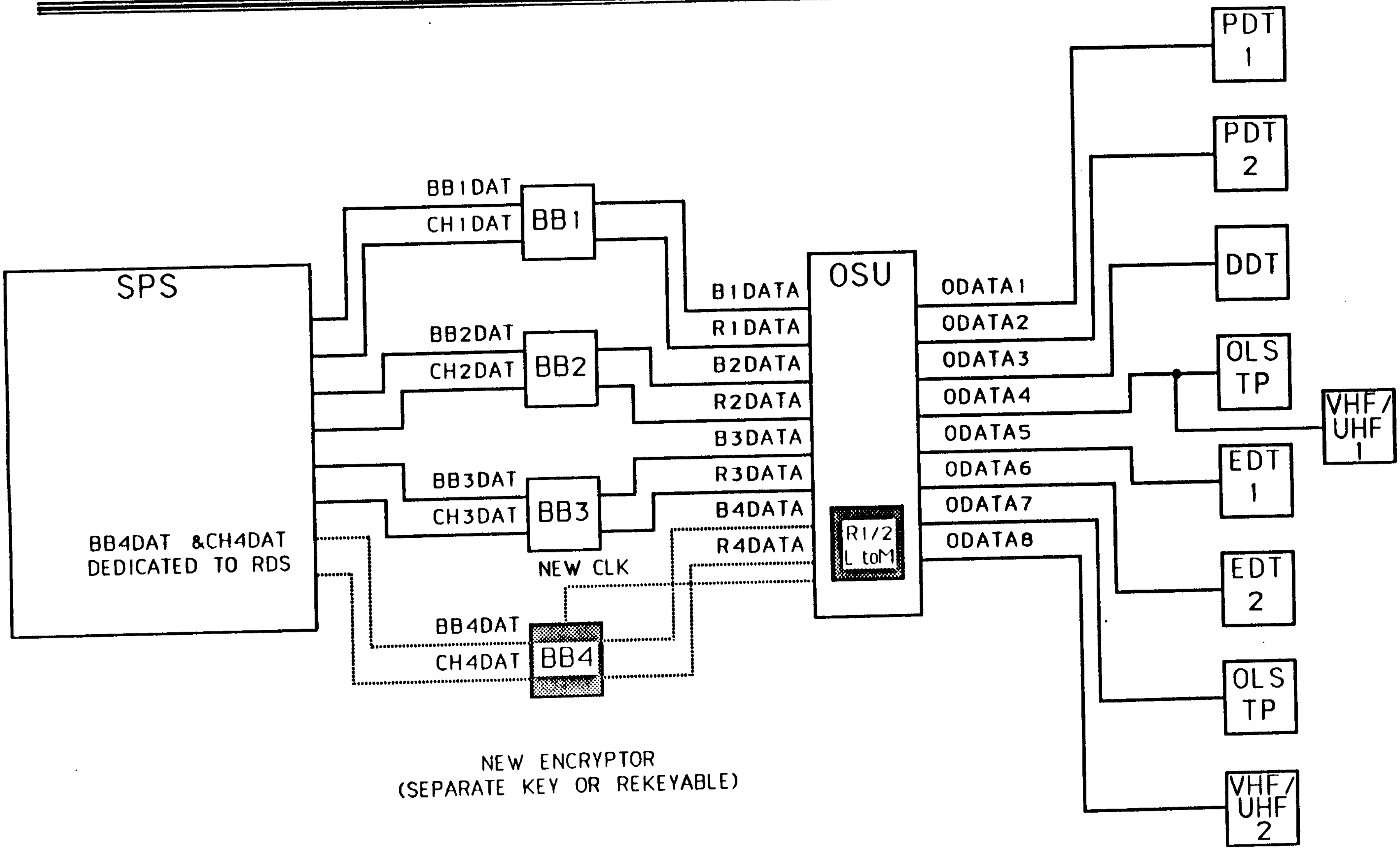
OLS VHF/UHF DIGITAL APPROACH



- THE VHF/UHF DIGITAL APPROACH WILL REQUIRE MODIFICATIONS TO THE SPS AND OSU TO PROVIDE A CLEAN PERMANENT INTERFACE BETWEEN THE SPS, ENCRYPTERS, OSU AND TRANSMITTERS
- THE TEST CONNECTOR USED IN THE OTHER APPROACHES WILL BE USED ONLY FOR TESTING, REDUCING IMPACT ON GROUND TEST PROCEDURES
- SPS WILL BE MODIFIED TO DEDICATE DATA LINES BB4DAT AND CH4DAT TO THE RDS STREAM
- A NEW ENCRYPTER, EITHER REKEYABLE OR WITH A KEY DIFFERENT FROM THE PRIMARY DATA ENCRYPTERS, WILL BE DEDICATED TO RDS - THE OLS ALREADY HAS LINES TO CONTROL A FOURTH ENCRYPTER
- OSU WILL BE CHANGED TO:
  - PROVIDE 66.56 OR 88.746 KHZ CLOCK TO NEW ENCRYPTER
  - "RATE 1/2" ENCODE RDS WITH 7 POLYNOMIAL ALGORITHM
  - CONVERT NRZ-L TO NRZ-M

OLS VHF/UHF DIGITAL APPROACH

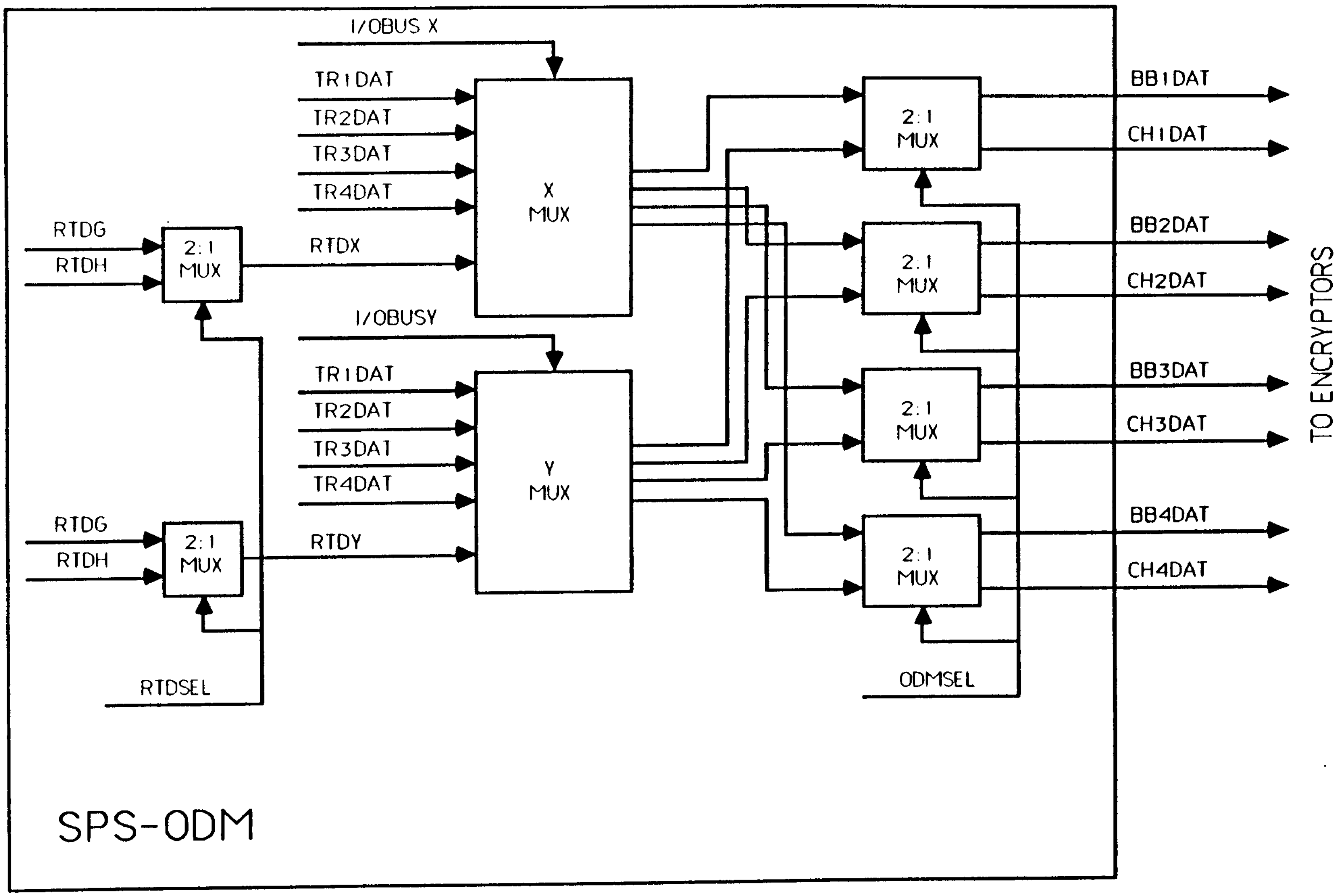




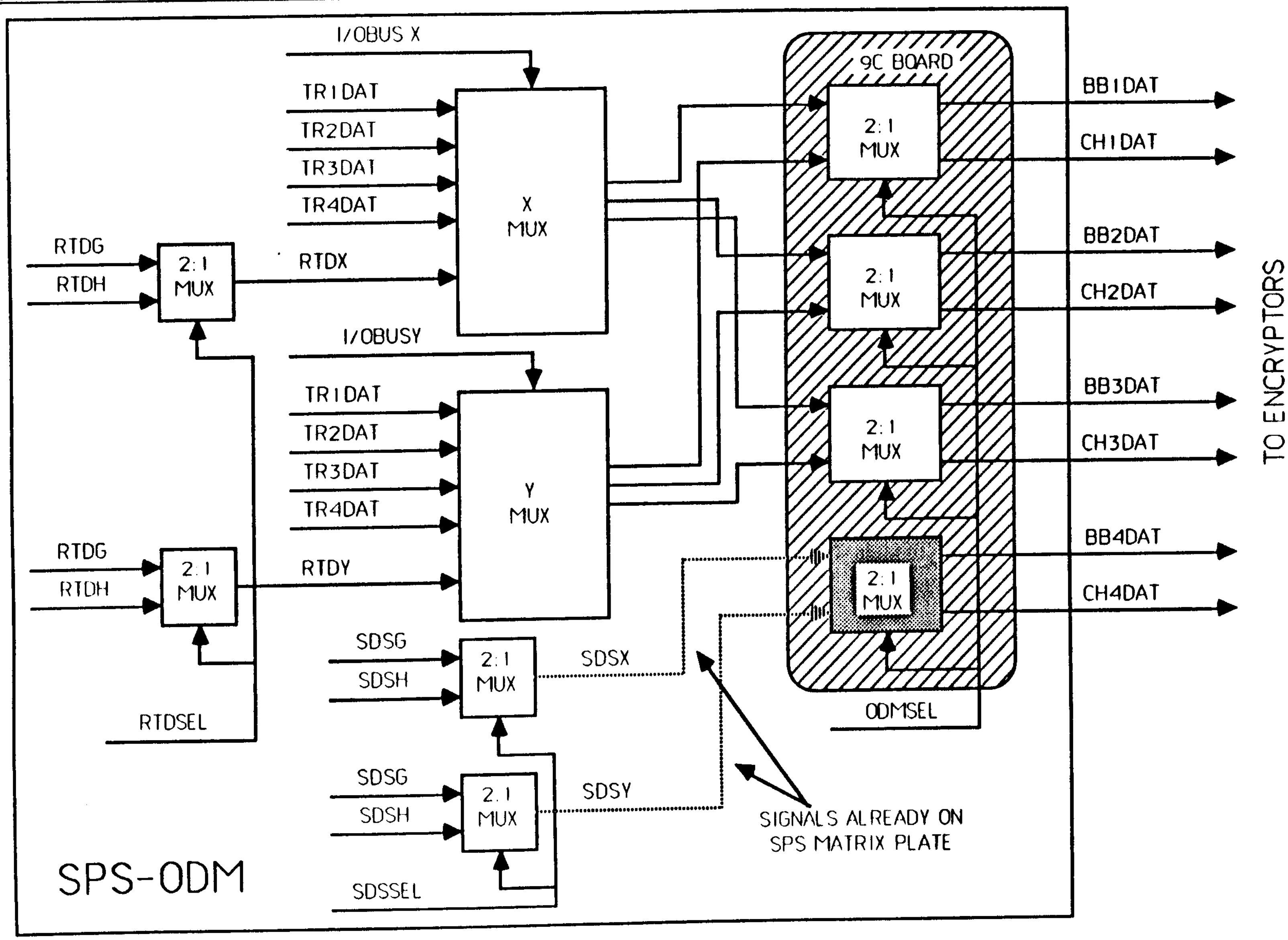
OLS VHF/UHF DIGITAL APPROACH-SPS

- THE VHF/UHF DIGITAL APPROACH WILL REQUIRE THE FOLLOWING MODIFICATIONS TO THE SPS
  - MATRIX PLATE MUST BE MODIFIED TO ROUTE SDS DATA TO THE 9C OUTPUT DATA MUX BOARD
  - MODIFY 9C BOARD TO MUTIPLEX THE SDSX AND SDSY DATA TO THE ENCRYPTER THROUGH BB4DAT AND CH4DAT
- A REKEYABLE ENCRYPTER MAY REQUIRE ADDITIONAL MODIFICATIONS TO THE SPS TO PROVIDE COMMUNICATION BETWEEN THE OLS PROCESSOR AND THE ENCRYPTER

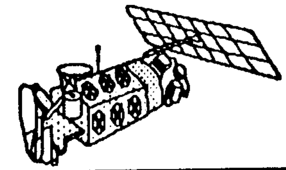
CURRENT OLS OUTPUT DATA MUX



VHF/UHF DIGITAL APPROACH - OLS ODM

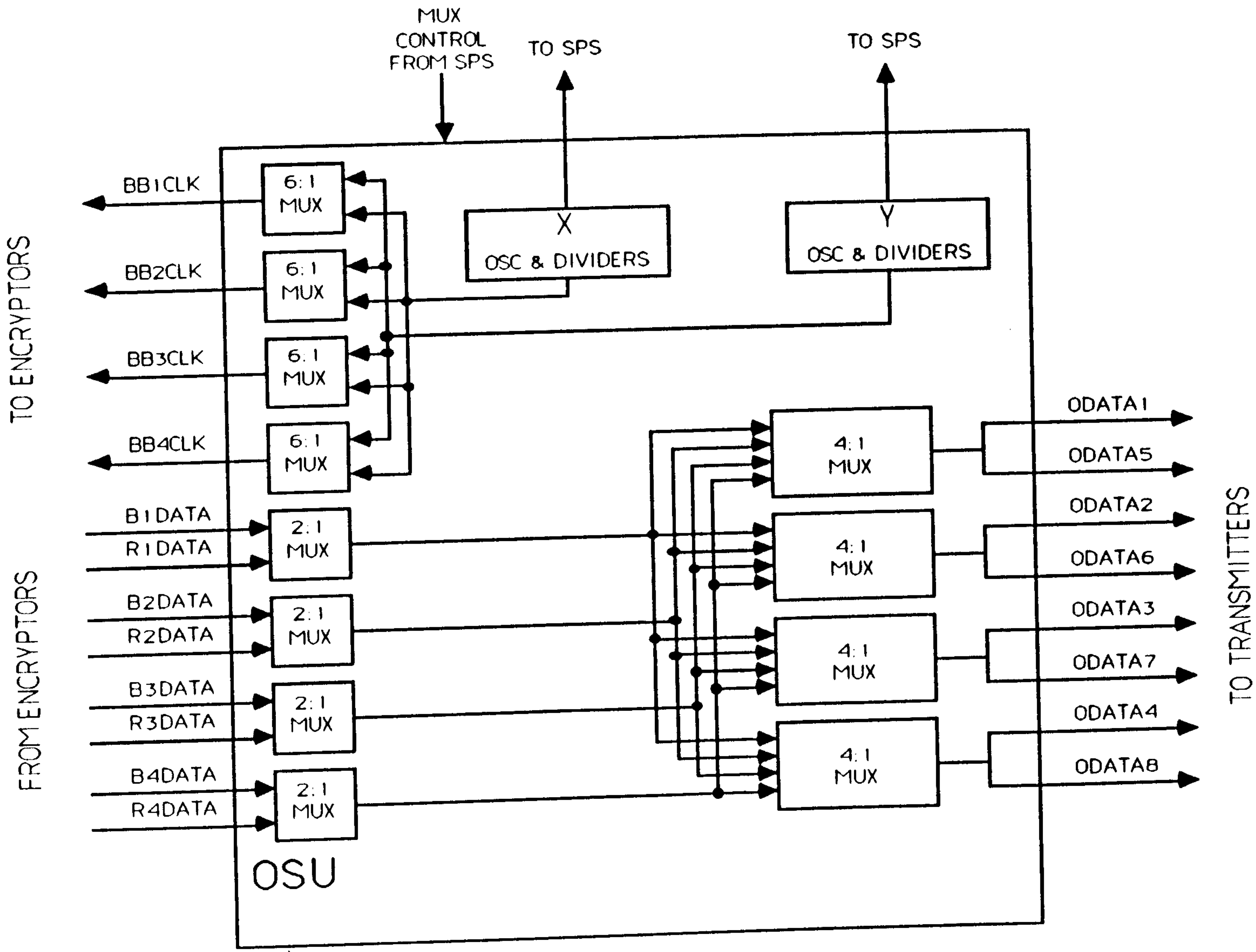


OLS VHF/UHF DIGITAL APPROACH-OSU

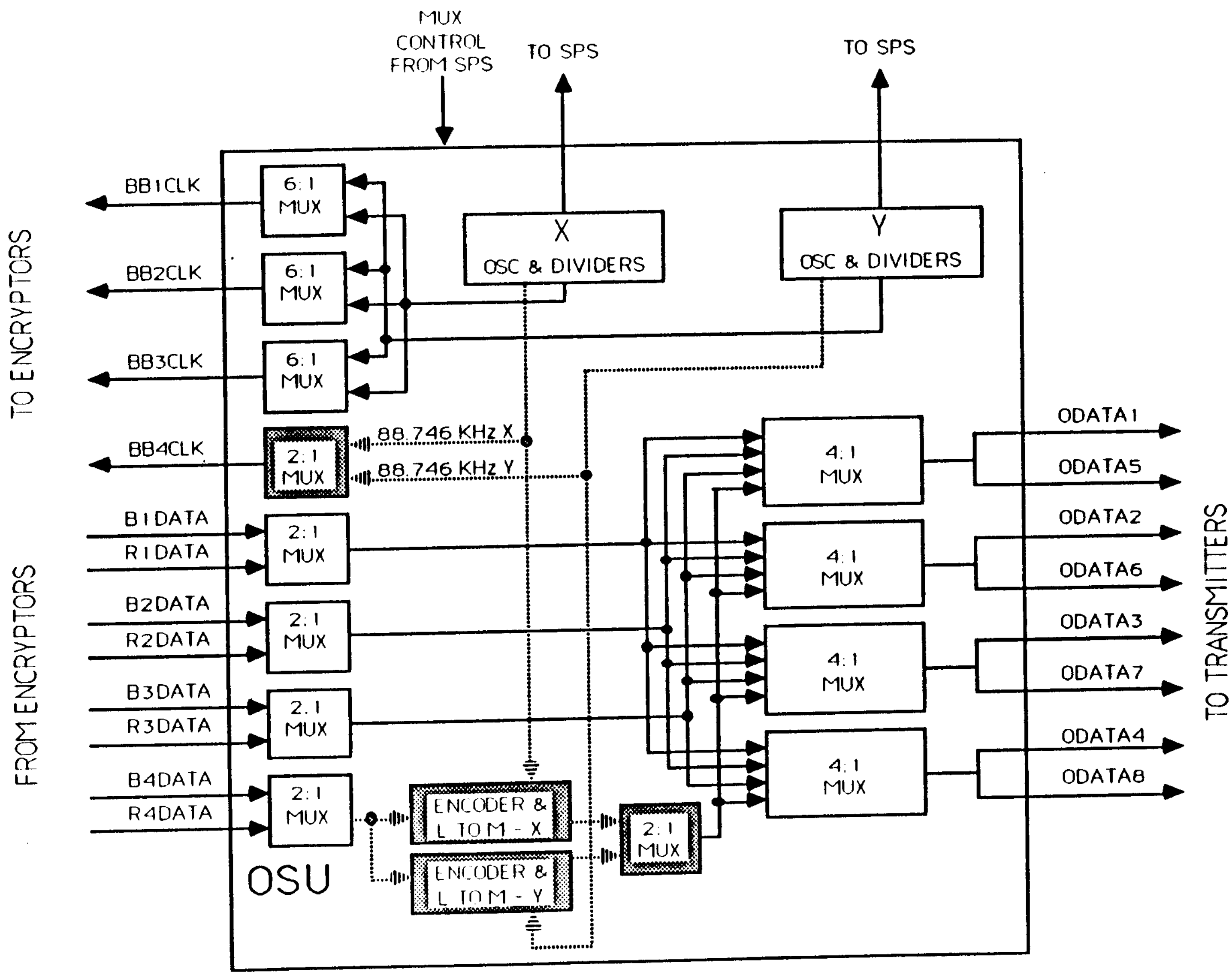


- THE VHF/UHF DIGITAL APPROACH WILL REQUIRE THE FOLLOWING MODIFICATIONS TO THE OSU AND ITS TWO BOARD ASSEMBLIES
  - NEW CLOCK DIVIDER MUST BE ADDED TO PROVIDE 88.746 KHZ CLOCK TO ENCRYPTER AND RATE 1/2 ENCODER
  - CIRCUITRY MUST BE ADDED TO ENCODE THE DATA USING A 7 POLYNOMIAL RATE 1/2 ALGORITHM
  - CONVERT DATA FROM NRZ-L TO NRZ-M
  - MUXING SCHEME MUST BE MODIFIED TO DEDICATE ENCRYPTER-4 TO RDS
  - MATRIX PLATE MUST BE MODIFIED TO REROUTE SIGNALS
- RATE 1/2 ENCODED NRZ-M RDS DATA WILL BE AVAILABLE TO ALL S-BAND TRANSMITTERS IN ADDITION TO THE VHF OR UHF TRANSMITTERS

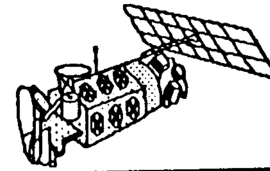
CURRENT OLS OUTPUT SWITCHING UNIT



VHF/UHF DIGITAL APPROACH OLS OSU

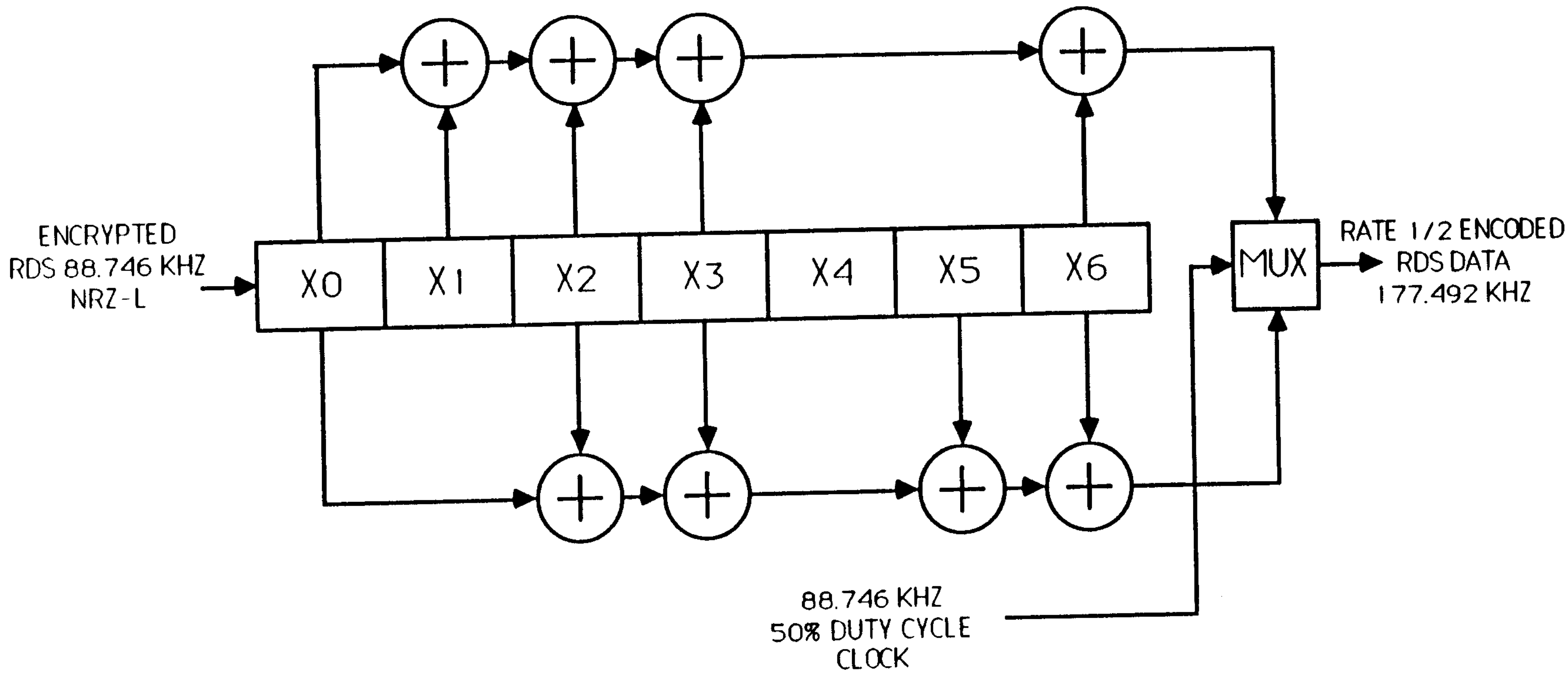


RATE 1/2 ENCODER ALGORITHM

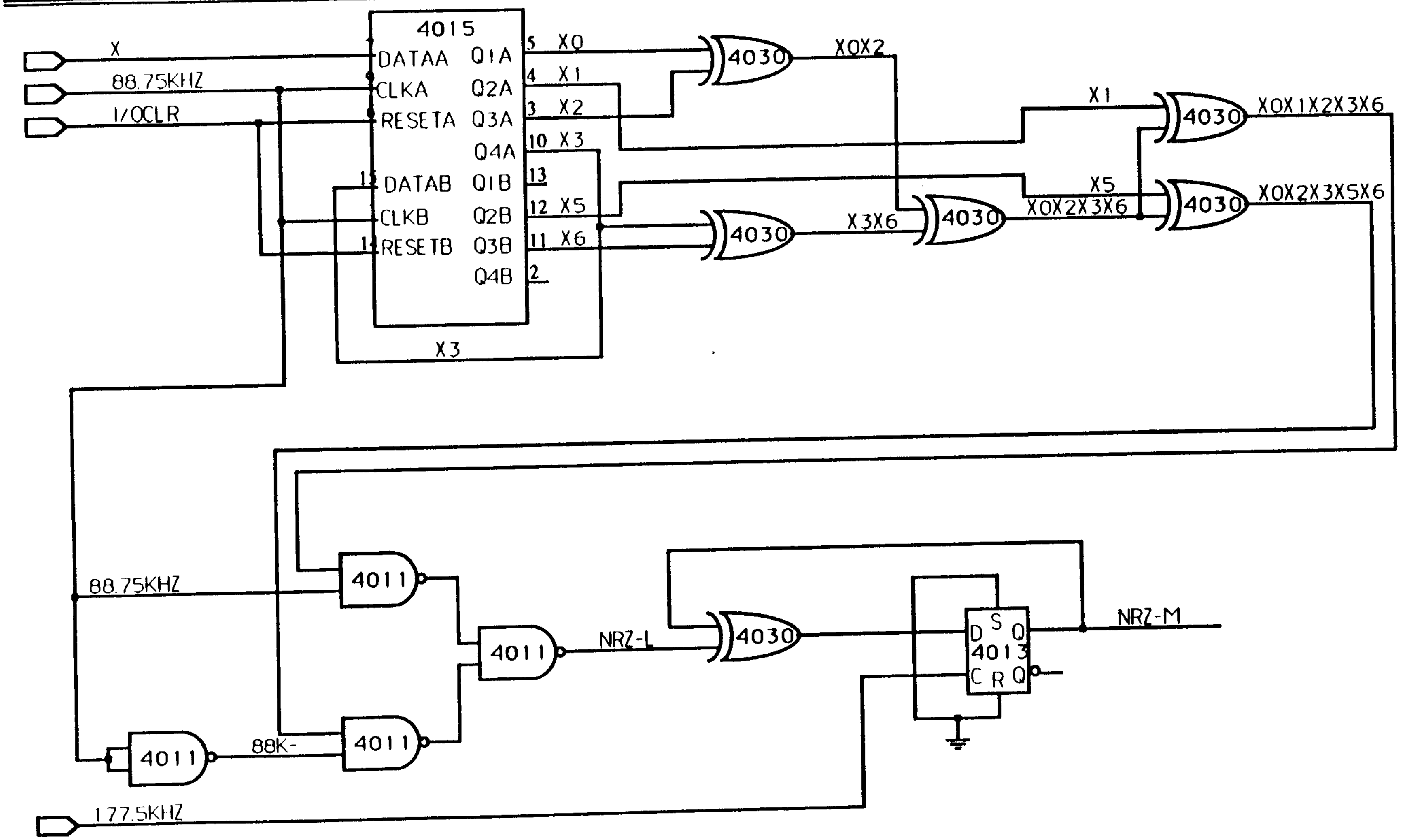


- TO INCREASE THE LINK MARGIN, THE ENCRYPTED REAL-TIME DATA SMOOTH IS REPROCESSED IN THE OSU
  - THE NRZ-L DATA FROM THE ENCRYPTER IS RATE 1/2 ENCODED WITH A 7 POLYNOMIAL CONVOLUTIONAL CODE
  - THE ENCODED NRZ-L DATA IS THEN CONVERTED TO NRZ-M
- CURRENTLY, THERE IS ENOUGH SPACE IN THE OSU FOR APPROXIMATELY 34 16-PIN INTEGRATED CIRCUITS
- IT WILL TAKE AN ESTIMATED 5 INTEGRATED CIRCUITS TO DO THE ENCODING AND CONVERSION PER SIDE (10 TOTAL), AND ANOTHER 4 PARTS PER SIDE TO CREATE THE 88.746 KHZ CLOCK (8 TOTAL)

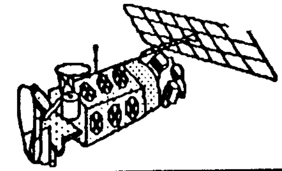
RATE 1/2 ENCODER ALGORITHM

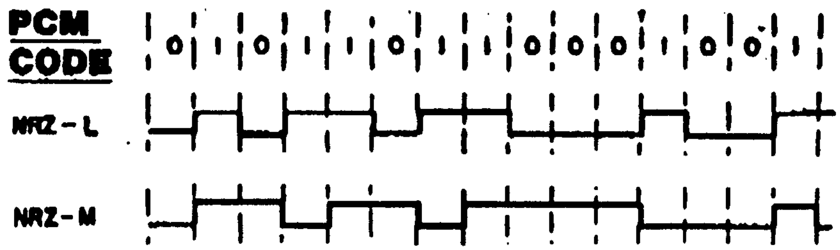


RATE 1/2 ENCODER & NRZ CONVERTER



NRZ-L TO NRZ-M CONVERSION





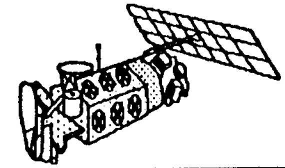
L = level
M = Mark

NRZ-M used to avoid problem of invert data reception, which can happen in PSK

NRZ-L "1" Represented by a voltage level during the entire bit period.
"0" Represented by a voltage level which is negative with respect to the level for a "1" during the entire bit period.

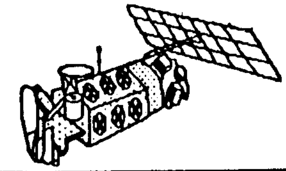
NRZ-M "1" Represented by a voltage transition at the beginning of the bit perio
"0" Represented by no voltage transition.

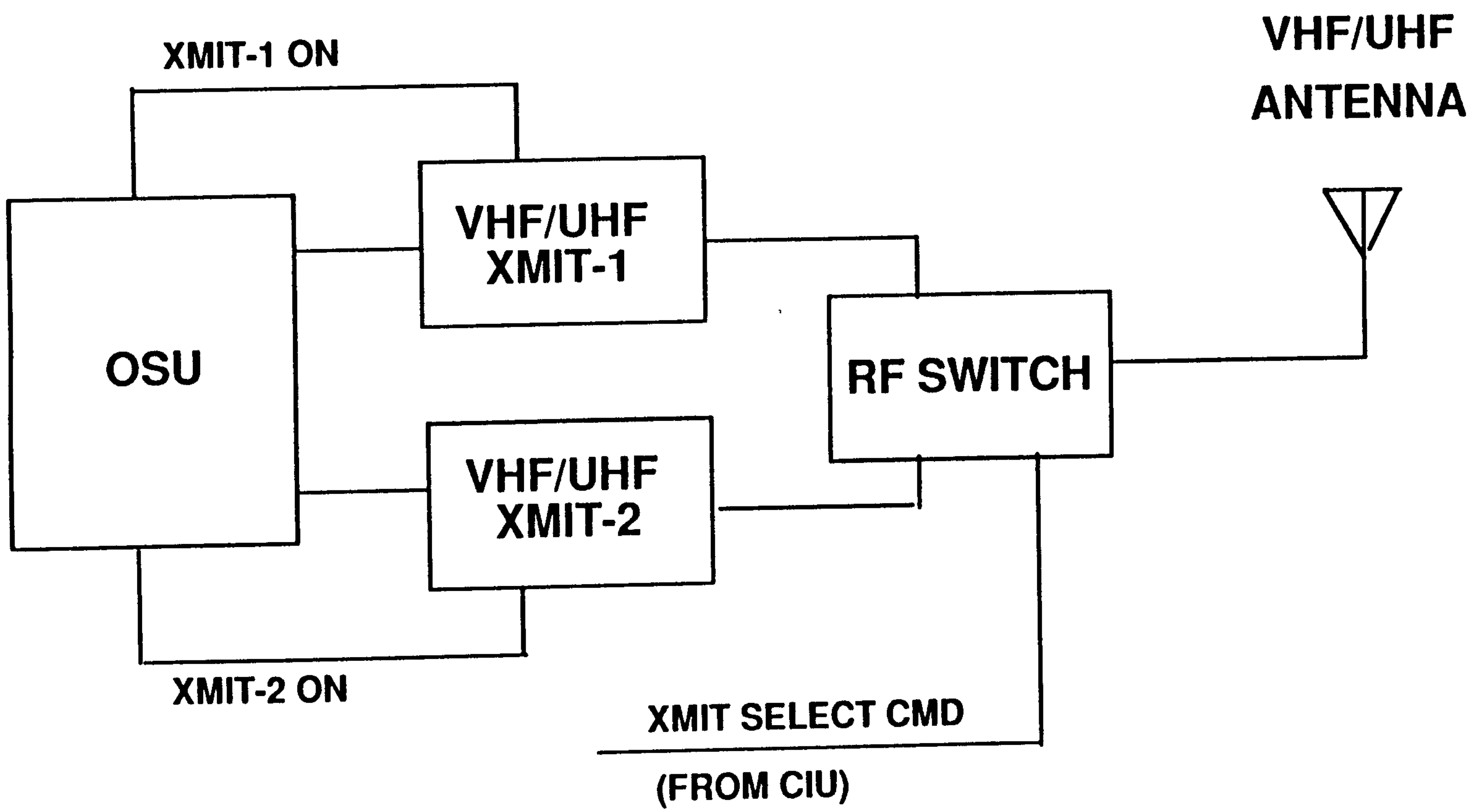
VHF/UHF DIGITAL-SPACECRAFT COMMUNICATIONS



- VHF/UHF digital concepts for RDS data transmission:
  - Tradeoff between various carrier frequencies between 137 MHz and 400 MHz
    - Carrier frequencies under consideration were selected based upon frequency allocation tables in <u>Manual of Regulations and Procedures for Federal Radio Frequency Management</u>, published by the National Telecommunications & Information Administration
  - Tradeoff between GE-designed transmitter and vendor-designed transmitter

VHF/UHF DIGITAL - SPACECRAFT COMMUNICATIONS





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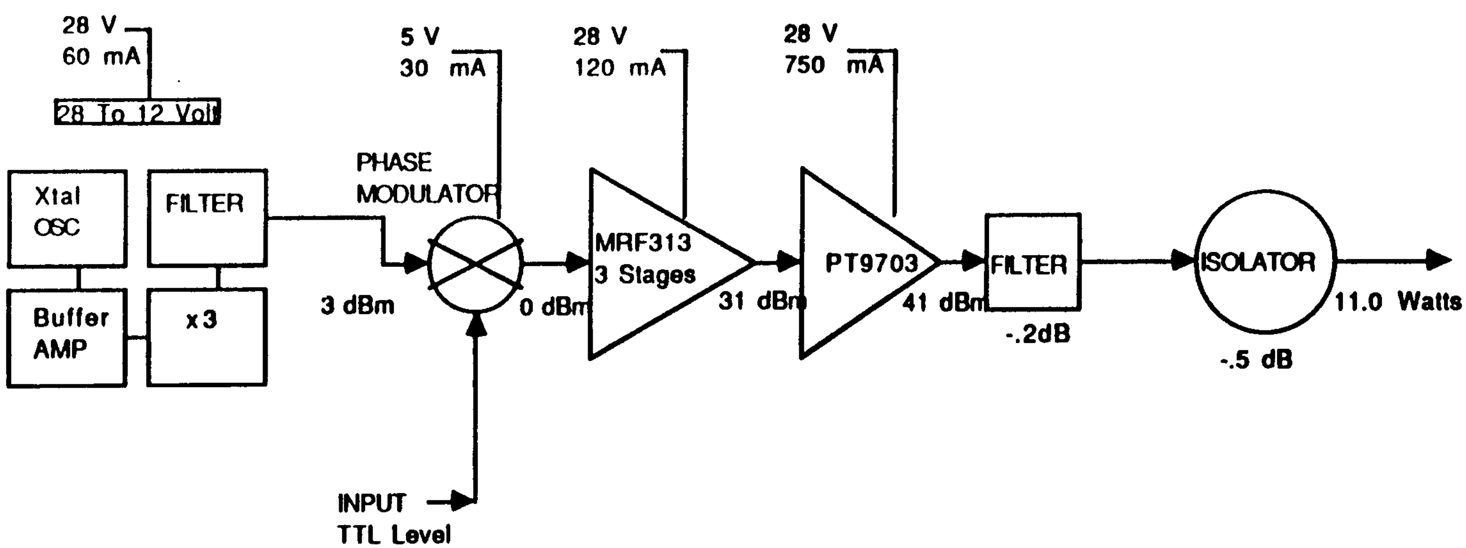
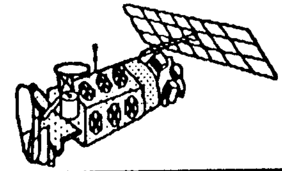
VHF/UHF DIGITAL TRANSMITTER - GE DESIGN

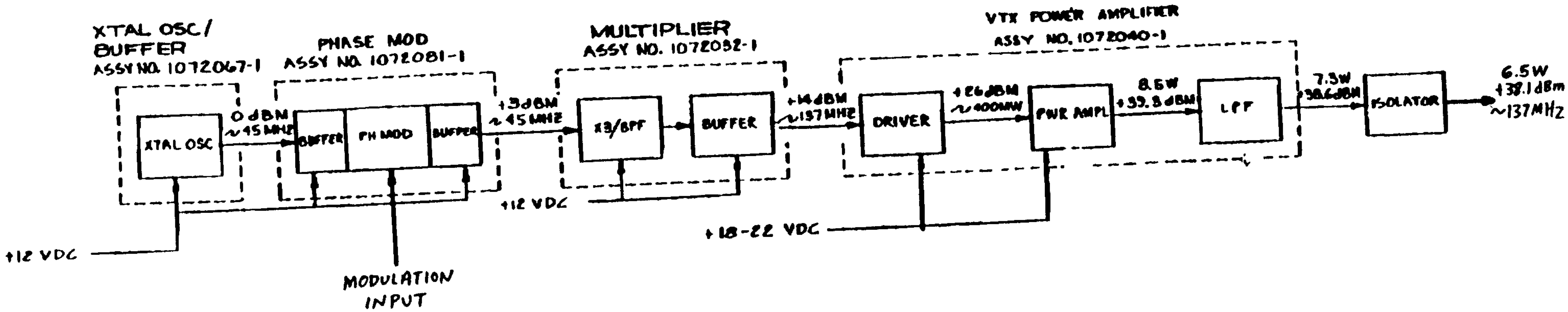


VHF/UHF DIGITAL TRANSMITTER - GE DESIGN



- Proposed design is usable between 137 MHz and 400 MHz (with use of appropriate multipliers)
- Additional stages of amplification can be added to boost power if necessary
- Phase modulator is double balanced mixer from Anzac
- Isolator is "lumped element" type from Pacific Microwave
- Oscillator assembly and filter are heritage Astro designs
- Motorola transistors used in power amplifier

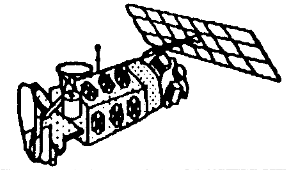
VHF/UHF DIGITAL TRANSMITTER - VENDOR DESIGN



VHF/UHF DIGITAL TRANSMITTER-
VENDOR DESIGN

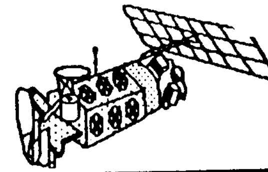
- TIROS BTX (VHF Beacon transmitter) design is used as a baseline, with modified amplifier design
- Block diagram shown is for operation at 137 MHz
- For operation at higher frequencies, appropriate multipliers would be added
- Additional stages of amplification can be added to boost output power if necessary

VHF/UHF DIGITAL - ANTENNA OPTIONS



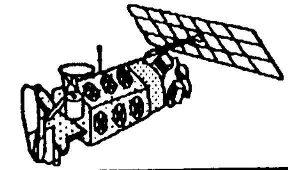
Frequency	Proposed Antenna
137 MHz	TIROS VRA (APT link antenna)
270 MHz	TIROS SRA (Search and Rescue link antenna)
400 MHz	TIROS UDA (Data collection link antenna)

VHF/UHF ANTENNA CHARACTERISTICS



- GAIN
  - Per requirements table (following page)
- POLARIZATION
  - Right-hand circular
- BEAMWIDTH
  - To spacecraft antenna α angles of 56°, which corresponds to ground elevation angle of 20°

VHF / UHF ANTENNA GAIN REQUIREMENTS

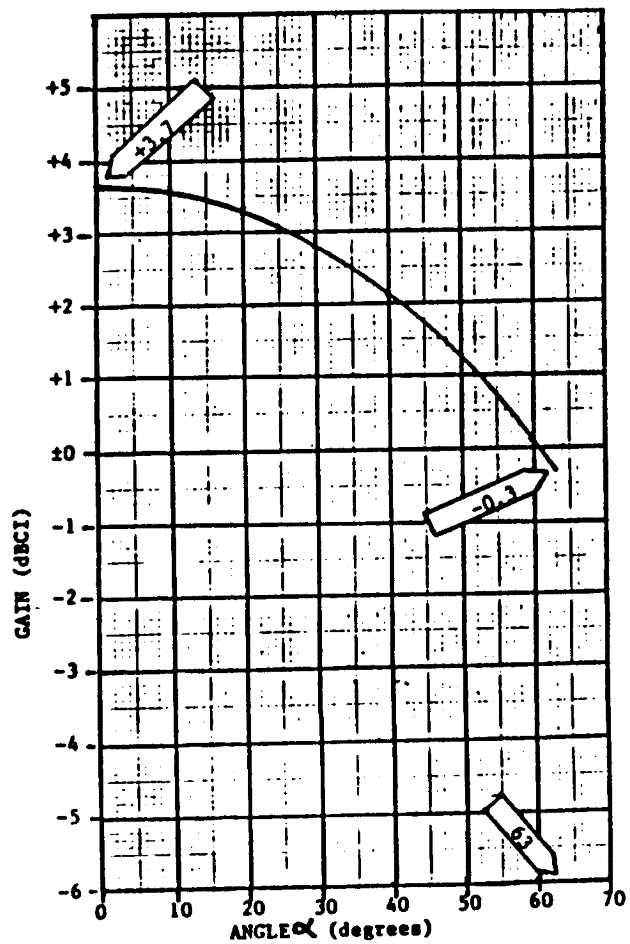


- **Based on 5W transmitter output**

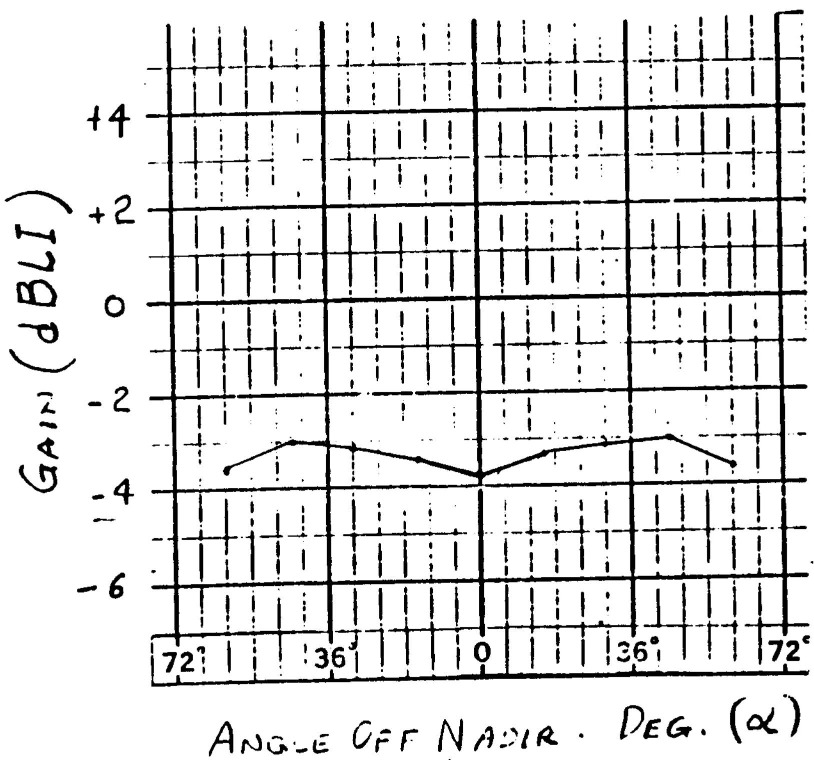
GROUND ELEVATION ANGLE	SPACECRAFT LOOK ANGLE	REQUIRED SPACECRAFT ANT. GAIN 137 MHz	225 MHz	400 MHz
0	62	5.8	5.8	10.8
5	62	4.4	4.4	9.4
10	61	3	3	8
15	59	1.7	1.7	6.7
20	56	0.5	0.5	5.5
25	53	-0.6	-0.6	4.4
30	50	-1.5	-1.5	3.5
35	46	-2.4	-2.4	2.6
40	43	-3.1	-3.1	1.9
45	39	-3.8	-3.8	1.2
50	35	-4.3	-4.3	0.7
55	30	-4.8	-4.8	0.2
60	26	-5.2	-5.2	-0.2
65	22	-5.6	-5.6	-0.6
70	18	-5.8	-5.8	-0.8
75	13	-6.1	-6.1	-1.1
80	9	-6.2	-6.2	-1.2
85	4	-6.3	-6.3	-1.3

Looking @ power boost.
Doesn't appear to be a problem at this point.
3→6 Db

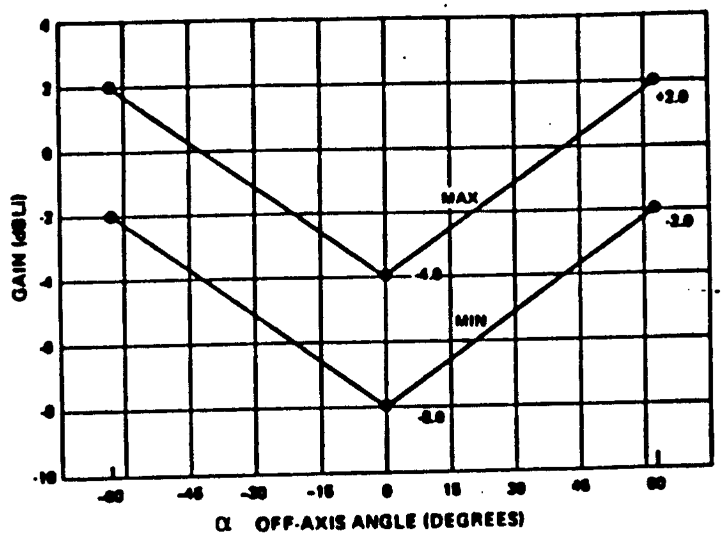
TIROS VRA ANTENNA GAIN



TIROS SRA ANTENNA GAIN



TIROS UDA ANTENNA GAIN



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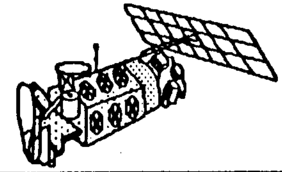
VHF / UHF LINK
POWER & WEIGHT ESTIMATES



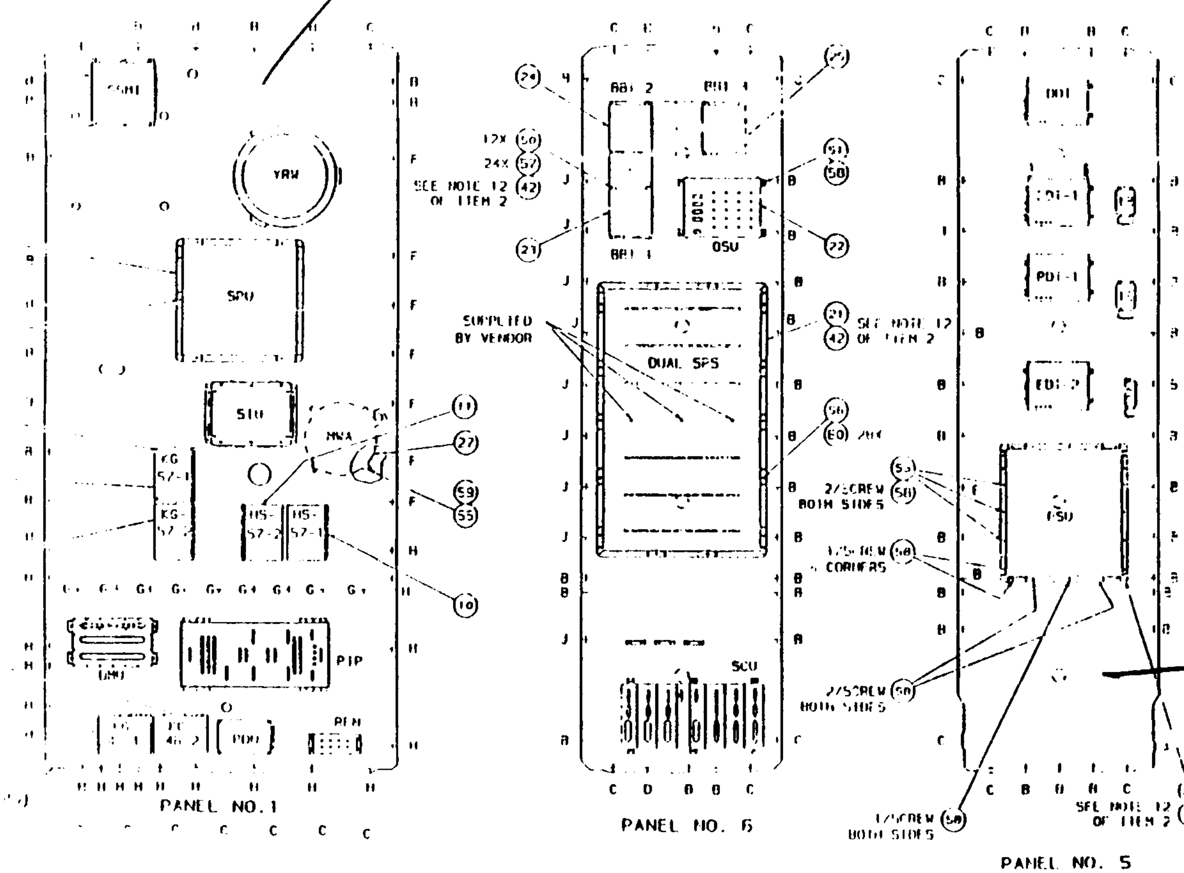
for 5 watt output

EQUIPMENT (new or Modified)	POWER (Watts)	WEIGHT (Lbs)
VHF/UHF XMIT 1	27.0	1.75
VHF/UHF XMIT 2	27.0	1.75
CRYPTO (Ricebird)	3.0	1.4
OSU (Encoder / Converter)	0.2	1.0
RF Switch	1.0	0.2
RF Antenna	...	3.9
CABLING	...	1.0
	----------	----------
TOTAL	31.2	11.0

vs 10 for KG.~~44~~. & Ricebird could be used on S-band.

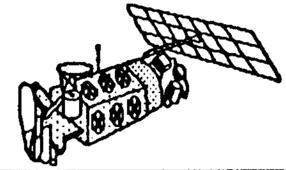
VHF/UHF APPROACH
PRELIMINARY LAYOUT OF NEW EQUIPMENT

encryptor



TX

VHF/UHF APPROACH
TELEMETRY & COMMAND SIGNALS



TELEMETRY

- XMIT 1 OUT POWER (A)
- XMIT 2 OUT POWER (A)
- XMIT 1 TEMP (A)
- XMIT 2 TEMP (A)
- XMIT 1 ON/OFF (D)
- XMIT 2 ON/OFF (D)

COMMAND

- OLS COMMANDS:
  XMIT 1 ON
  XMIT 2 ON
- CIU COMMAND:
  XMIT 1/2 SELECT

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VHF/UHF DIGITAL APPROACH EVALUATION CRITERIA

- SATELLITE COMPLEXITY
- RECEIVING SYSTEM COMPLEXITY
- AVAILABILITY OF MISSION SENSOR DATA
- FEASIBILITY OF ENCRYPTION
- RESOLUTION OF IMAGERY
- DIFFICULTY OF OBTAINING FREQUENCY ALLOCATION
- SUSCEPTIBILITY TO RADIO FREQUENCY INTERFERENCE (RFI)
- SUSCEPTIBILITY TO JAMMING

NOTE: THE SAME EVALUATION CRITERIA ARE USED FOR ALL APPROACHES

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REALTIME DATA SMOOTH (RDS) LINK BUDGET SUMMARY

CASE	REQUIRED RECEIVING ANTENNA GAIN	RECEIVING ANTENNA SIZE
1. 2237.5 MHz, SPACECRAFT OMNI ANT, 1.024 MHz SUBCARRIER	25.1 dB	4.0 FEET
2. 2237.5 MHz, SPACECRAFT DIRECTIONAL ANT, 1.024 MHz SUBCARRIER	18.3 dB	1.8 FEET
3. 2267.5 MHz, SPACECRAFT DIRECTIONAL ANT, DIRECT MODULATION	15.4 dB	1.3 FEET
4. 137.5 MHz, TIROS ANTENNA, DIRECT MODULATION, CONVOLUTIONAL CODING	-3.7 dB	OMNI
5. 225 MHz, TIROS-LIKE ANTENNA, DIRECT MODULATION, CONVOLUTIONAL CODING	-3.4 dB	OMNI

NOTE THAT THE VHF/UHF APPROACHES ONLY REQUIRE OMNIDIRECTIONAL RECEIVING ANTENNAS

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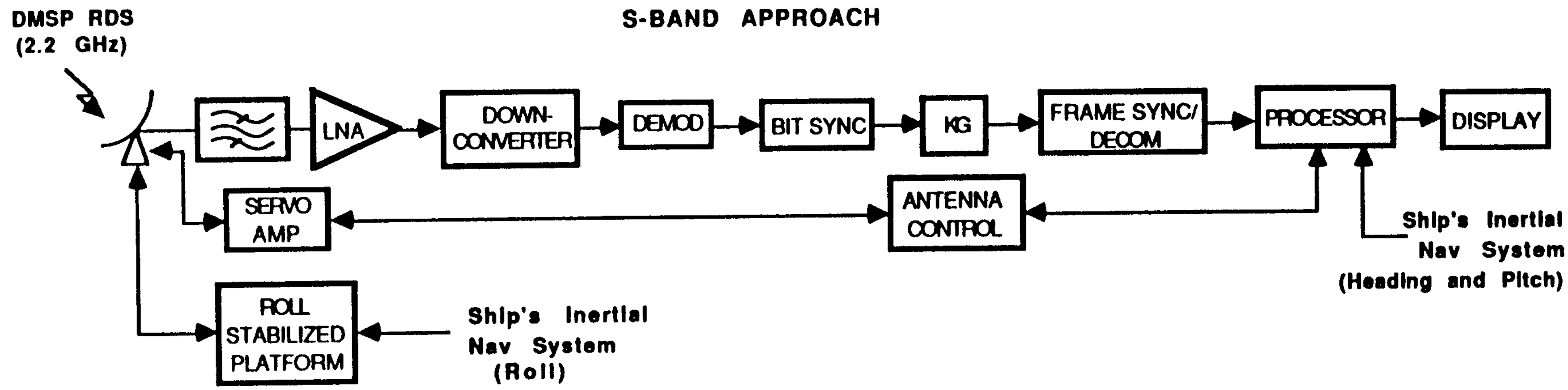
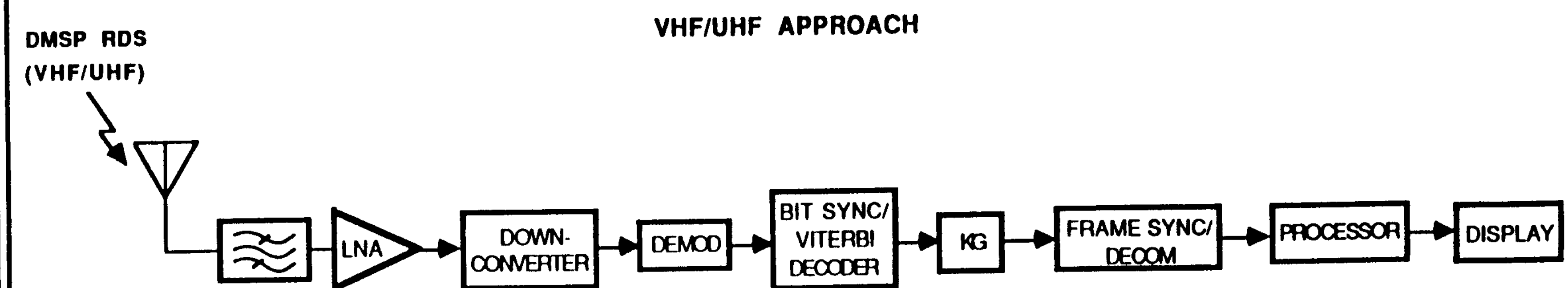
GENERALIZED BLOCK DIAGRAM FOR SHIPBOARD RDS RECEIVING SYSTEMS





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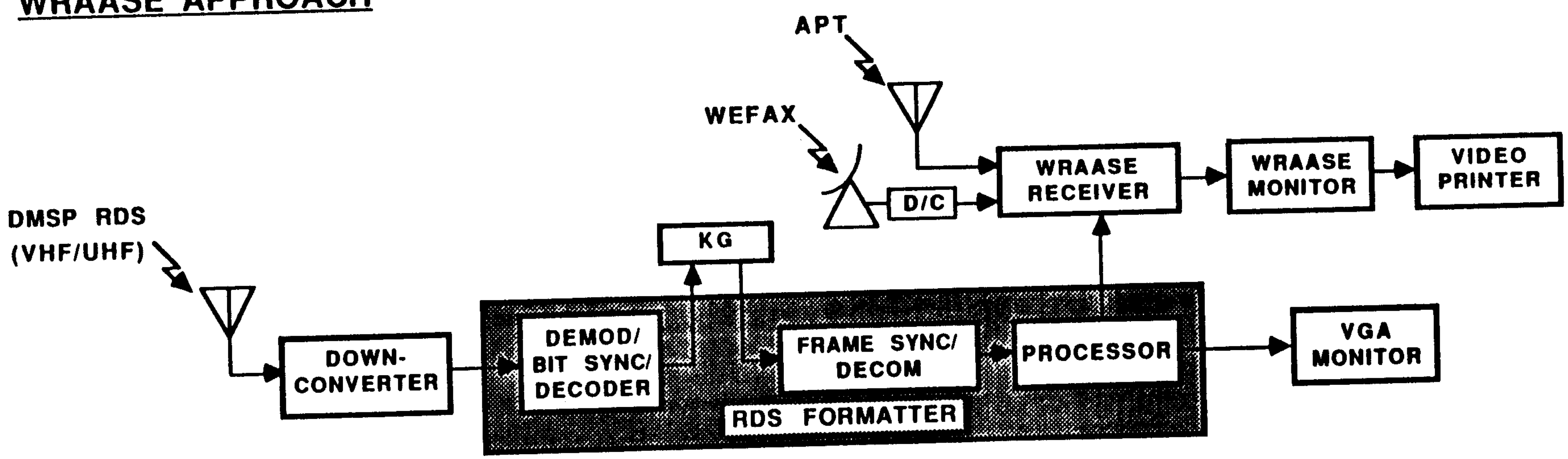
VHF/UHF DIGITAL APPROACHES FOR RDS RECEPTION

WRAASE APPROACH



Could use 1 antenna for RDS & APT

•NO PROVISIONS ARE MADE FOR POINTING THE WEFAX ANTENNA ABOARD SHIP

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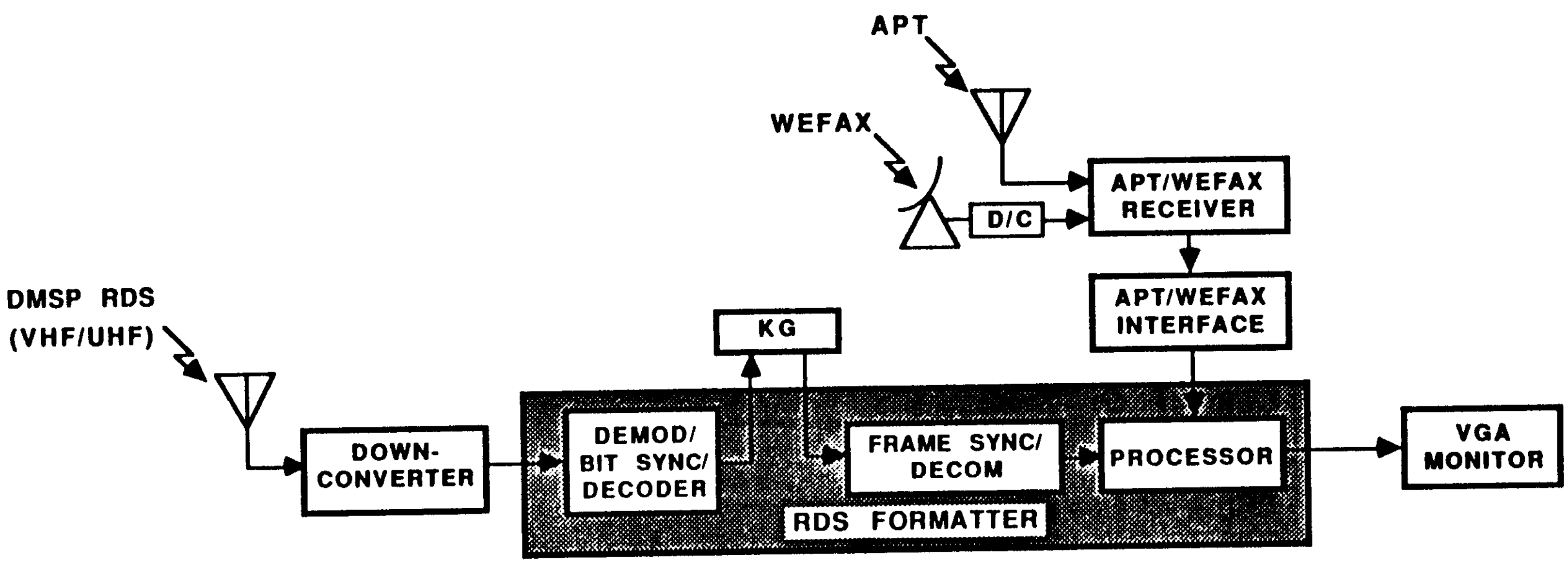
VHF/UHF DIGITAL APPROACHES FOR RDS RECEPTION

ALTERNATE APPROACH



•NO PROVISIONS ARE MADE FOR POINTING THE WEFAX ANTENNA ABOARD SHIP

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CHANGES TO RDS FORMATTER IN VHF/UHF APPROACHES

- VHF/ UHF APPROACHES USE THE SAME BASIC RDS FORMATTER AS THE S-BAND APPROACHES, WITH SOME FUNCTIONS DELETED:

  -ANTENNA POINTING FUNCTION IS NOT REQUIRED
  -SHIP'S INERTIAL NAV SYSTEM (SINS) INTERFACES ARE NOT REQUIRED

- VITERBI ERROR CORRECTION IS ADDED TO THE BIT SYNC CARD IN THE VHF/UHF VERSION

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PROS AND CONS OF VHF/UHF DIGITAL APPROACH

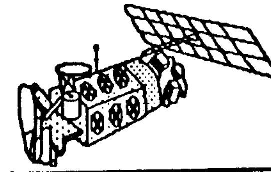
ADVANTAGES:

- DOES NOT REQUIRE STEERABLE ANTENNA IN RECEIVING SYSTEM
  - -REDUCES RECEIVING SYSTEM COMPLEXITY SIGNIFICANTLY
  - -GREATLY SIMPLIFIES SHIPBOARD INSTALLATION
- MISSION SENSOR DATA TRANSMITTED
- ENCRYPTION IS POSSIBLE
- FULL RDS RESOLUTION

DISADVANTAGES:

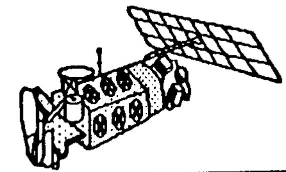
Not true vs Alternative #3 of S-band.

- MORE EXTENSIVE SATELLITE MODIFICATIONS THAN S-BAND APPROACH
  - -INCREASES SATELLITE COMPLEXITY
  - -DELAYS IMPLEMENTATION DATE
- FREQUENCY ALLOCATION MAY BE DIFFICULT
- OMNI ANTENNA IS MORE SUSCEPTIBLE TO RFI AND JAMMING



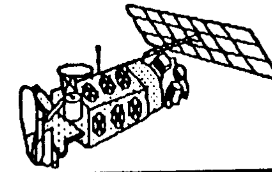
APT APPROACH FOR DMSP REALTIME DATA SMOOTH

DMSP APT OVERVIEW



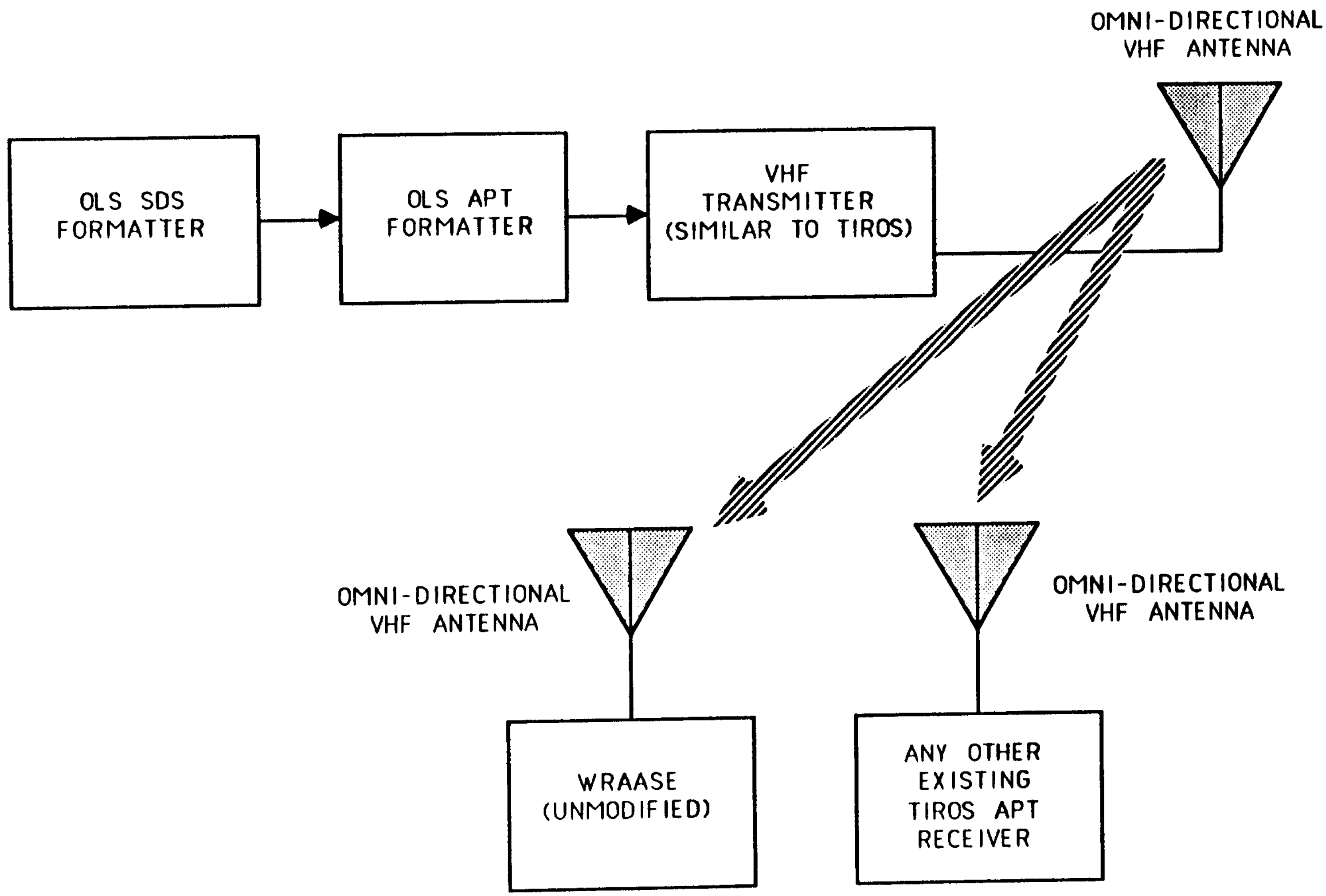
- THE SENSOR APPROACH FOR APT IS ESSENTIALLY UNCHANGED FROM THAT PRESENTED AT THE FIRST BRIEFING
- SPACECRAFT IMPACT
  - MODIFY OLS TO PROVIDE APT VERSION OF SMOOTH DATA STREAM
  - ADD UHF OR VHF MODULATOR/TRANSMITTER/ANTENNA ASSEMBLY TO SPACECRAFT
  - MODIFY SPACECRAFT HARNESS
- GROUND IMPACT
  - ESSENTIALLY NONE
  - WRAASE MAY BE USED UNMODIFIED, ONLY REQUIRES ADDITION OF A CRYSTAL

OLS APT OVERVIEW

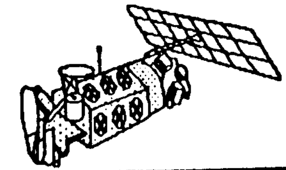


- ADVANTAGES
  - VHF ALLOWS USE OF SIMPLE OMNI-DIRECTIONAL VHF ANTENNA ON GROUND ELIMINATING ANTENNA TRACKING EQUIPMENT
  - DATA FORMAT COMPATIBLE WITH WIDE VARIETY OF EXISTING HARDWARE
  - GRIDDING AND TEXT WILL ALREADY BE IMBEDDED IN DATA STREAM
  - LOW TECHNOLOGY RISK - DMSP SPACECRAFT CONFIGURATION IS SIMILAR TO TIROS
- DISADVANTAGES
  - killer → ENCRYPTION IS NOT FEASIBLE
  - ALLOCATION OF NEW VHF FREQUENCY IS DIFFICULT
  - MODIFICATIONS TO SPACE SEGMENT ARE EXPENSIVE
  - NO MISSION SENSOR DATA
  - SIGNIFICANTLY LOWER RESOLUTION AND IMAGE QUALITY
  - WRAASE REDUCES RESOLUTION FURTHER BY DROPPING EVERY OTHER LINE AND SMOOTHING ACROSS SCAN

DMSP APT BLOCK DIAGRAM

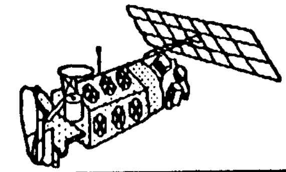


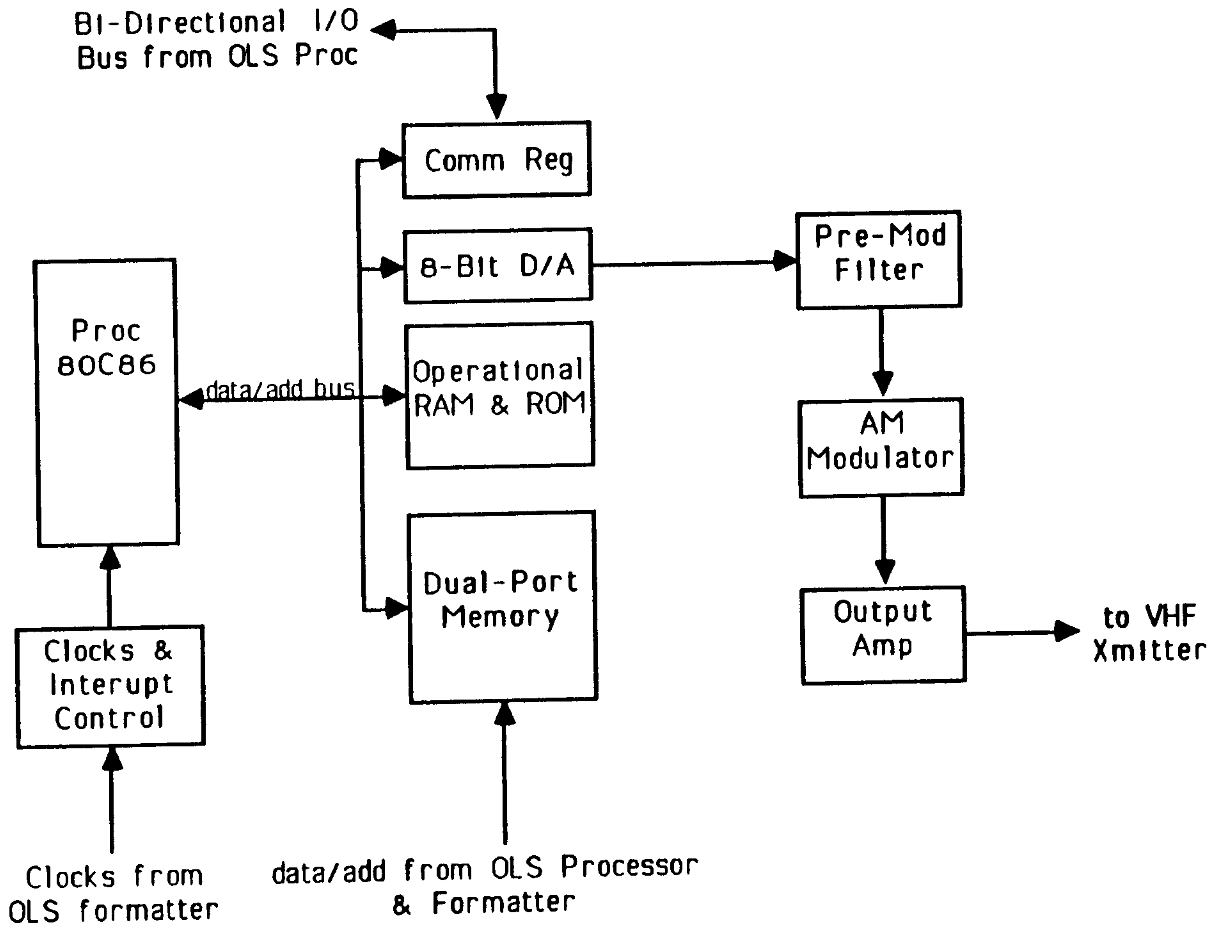
OLS APT FORMAT DESCRIPTION



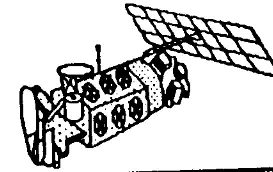
- OLS APT FORMAT WOULD DUPLICATE TIROS APT LINE STRUCTURE AS CLOSELY AS POSSIBLE
  - OLS APT WOULD DROP 1 OUT OF EVERY 25 SMOOTH LINES TO SYNCHRONIZE WITH THE SLOWER TIROS APT LINE RATE (500ms vs 420ms).
  - OLS APT WOULD USE AVERAGING ALGORITHM SIMILAR TO TIROS APT TO CORRECT FOR ACROSS TRACK IMAGE EXPANSION
  - ON BOARD PROCESSING WOULD SUPER-IMPOSE GRIDDING AND TEXT ON IMAGE - ON BOARD GRIDDING WOULD BE LESS ACCURATE THAN RDS PROCESSED ON GROUND DUE TO LIMITED PROCESSOR POWER (LOW SPEED AND LACK OF RAD-HARD COPROCESSOR) AND WRAASE RESOLUTION

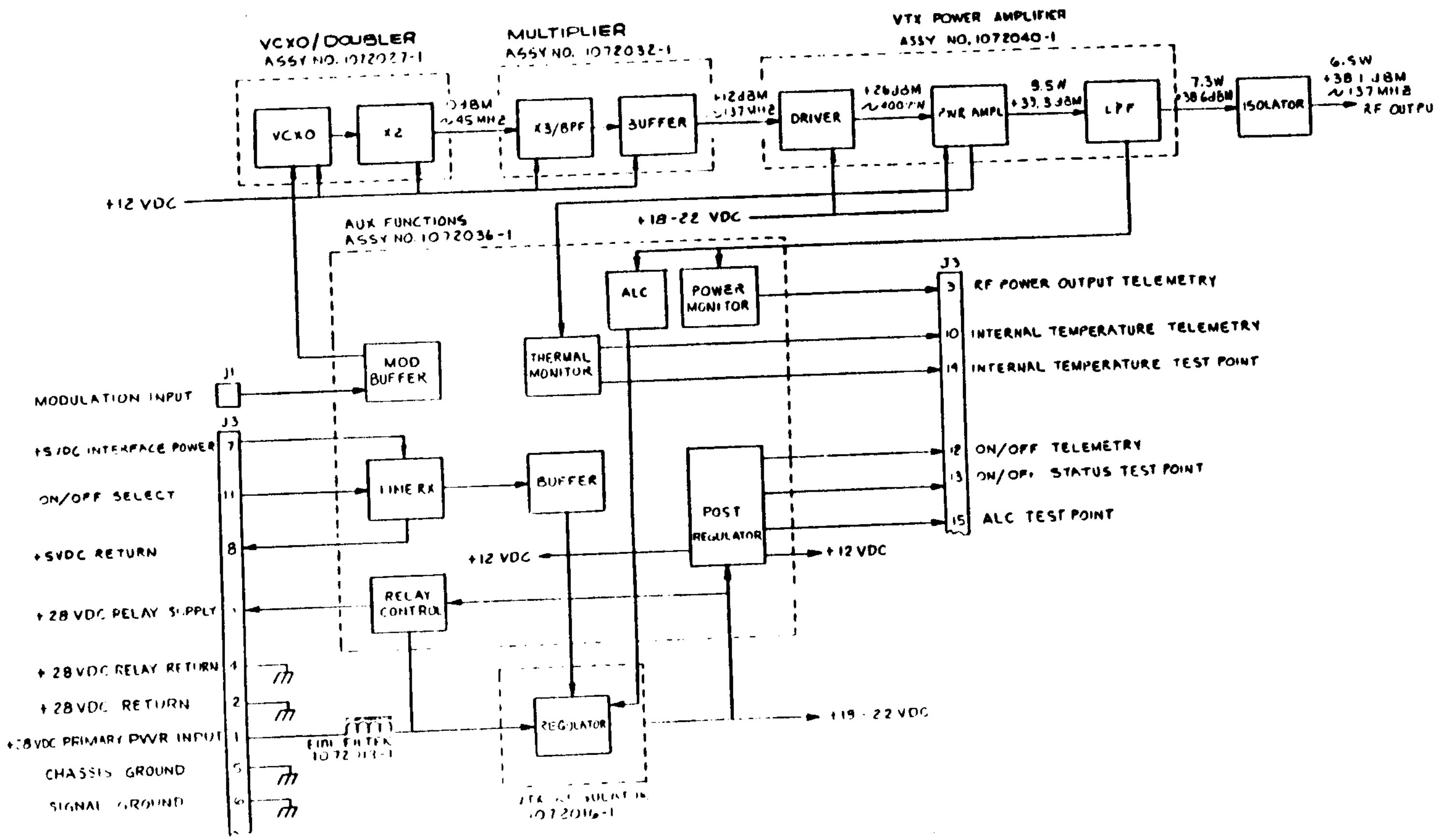
OLS APT FORMATTER



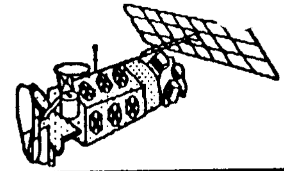


APT TRANSMITTER - EXISTING DESIGN



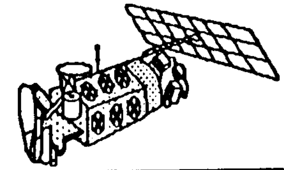


APT APPROACH
POWER & WEIGHT ESTIMATES FOR NEW UNITS



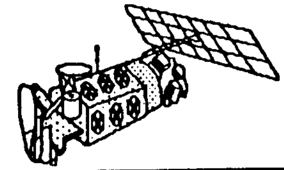
UNIT	POWER (Watts)	WEIGHT (lbs)
APT VHF XMIT 1	20.6	1.75
APT VHF XMIT 2	20.6	1.75
RF SWITCH	1.0	0.2
RF ANTENNA	...	3.9
CABLING	...	1.0
OLS MISCELLANEOUS	0.5	1.0
TOTAL	22.1	9.6

APT APPROACH
PRELIMINARY LAYOUT OF NEW EQUIPMENT



SAME AS S-BAND & VHF/UHF APPROACHES

APT APPROACH
TELEMETRY & COMMAND SIGNALS



SAME AS S-BAND & VHF/UHF
APPROACHES

APT APPROACH EVALUATION CRITERIA

- SATELLITE COMPLEXITY
- RECEIVING SYSTEM COMPLEXITY
- AVAILABILITY OF MISSION SENSOR DATA
- FEASIBILITY OF ENCRYPTION
- RESOLUTION OF IMAGERY
- DIFFICULTY OF OBTAINING FREQUENCY ALLOCATION
- SUSCEPTIBILITY TO RADIO FREQUENCY INTERFERENCE (RFI)
- SUSCEPTIBILITY TO JAMMING

NOTE: THE SAME EVALUATION CRITERIA ARE USED FOR ALL APPROACHES

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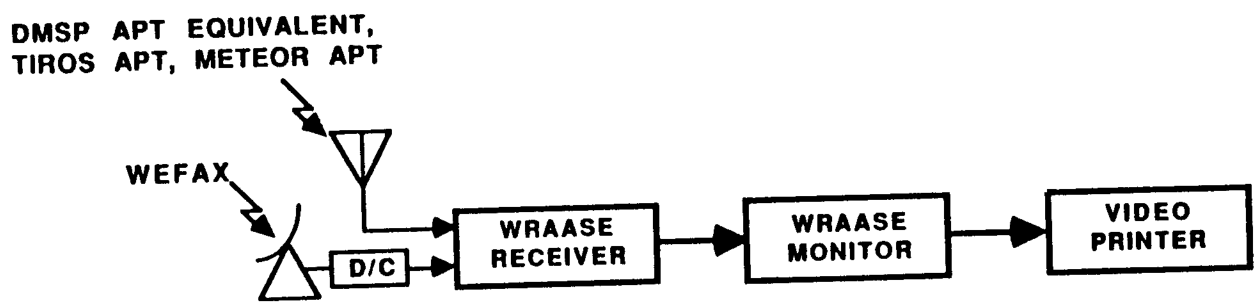
COMPARISON OF RDS AND APT RESOLUTION

	RDS	APT
PIXELS / LINE	1465	512
LINES / IMAGE (18 MINUTE PASS)	2566	1283
ZOOM CAPABILITY:	YES	NO

NOTE: THE RESOLUTION SHOWN FOR APT IS THAT OF THE WRAASE RECEIVER WHEN SET UP FOR APT RECEPTION

APPROACHES FOR APT RECEPTION

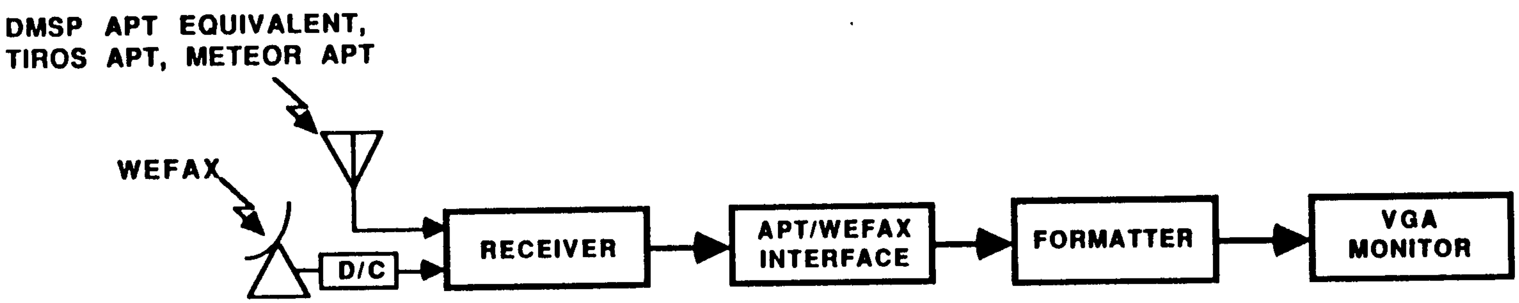
WRAASE APPROACH



•NO PROVISIONS ARE MADE FOR POINTING THE WEFAX ANTENNA ABOARD SHIP

APPROACHES FOR APT RECEPTION

ALTERNATE APPROACH



•NO PROVISIONS ARE MADE FOR POINTING THE WEFAX ANTENNA ABOARD SHIP

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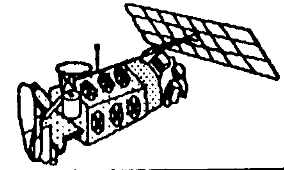
PROS AND CONS OF APT APPROACH

ADVANTAGES:

- WRAASE EQUIPMENT CAN BE USED AS-IS

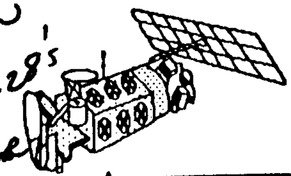
DISADVANTAGES:

- MOST EXTENSIVE SATELLITE MODIFICATIONS OF ALL THREE APPROACHES
  - GREATEST SATELLITE COMPLEXITY
  - LATEST IMPLEMENTATION DATE
- NO MISSION SENSOR DATA
- NO ENCRYPTION
- REDUCED RESOLUTION
- OMNI ANTENNA IS MORE SUSCEPTIBLE TO RFI AND JAMMING



ENCRYPTION

ENCRYPTION



either needs KG-44 or KG 46 on gnd. 44's & KGR-28's are hard to come by, if not impossible

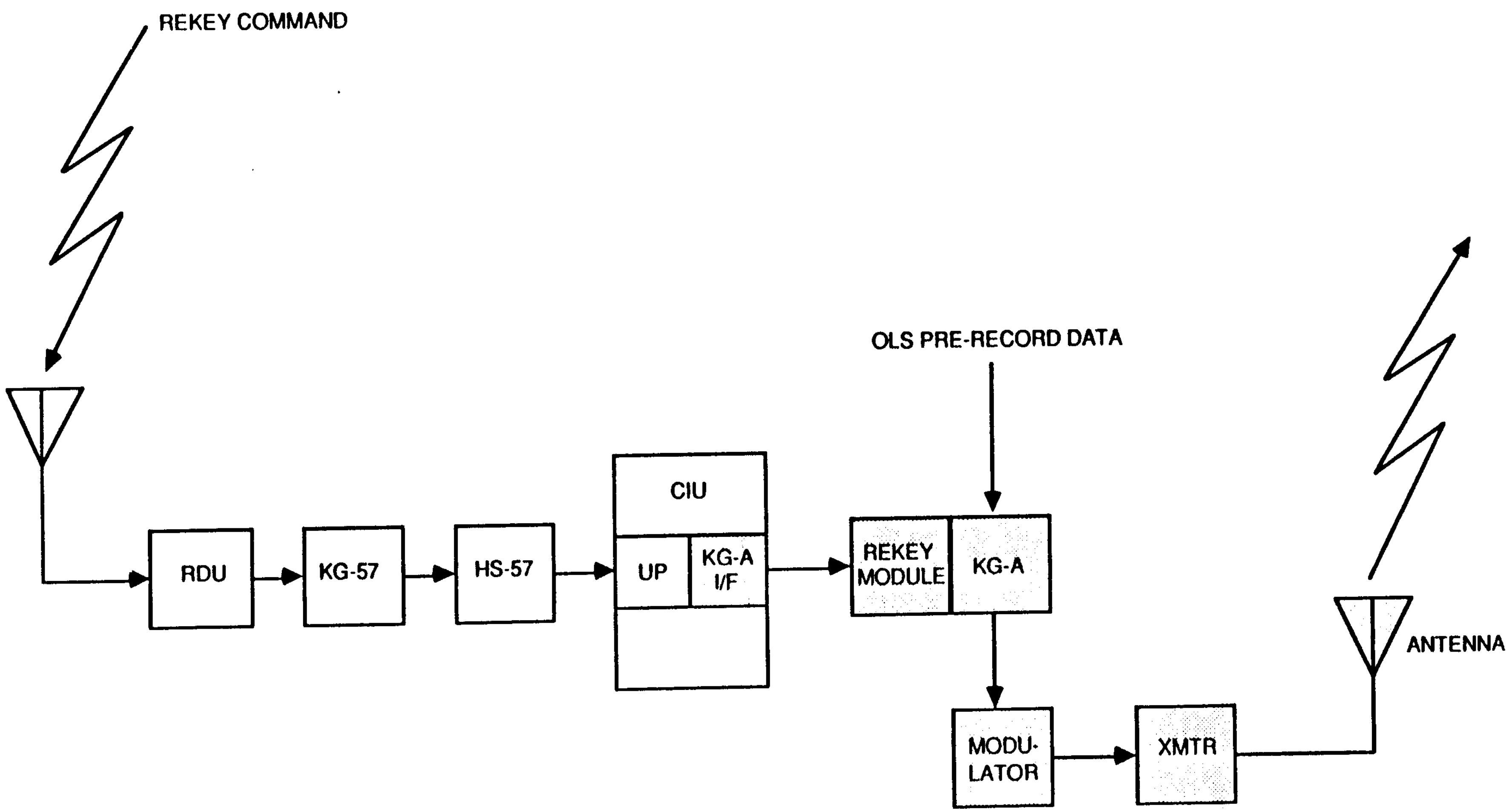
Short-term Demonstration System

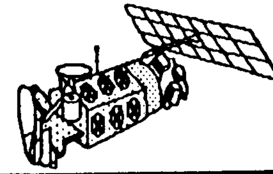
- use additional KG-43 unit (BB4)
- interface will be the same as for existing KG-43 units (BB1-BB3)
- no rekey capability, but key can be selected to be unique from other DMSP encrypted links
- KG-43 permits clear/encrypt select

Long-Term Operational System

- use redundant Ricebird KG-A units with associated rekey modules
- rekey command traffic will be via existing encrypted, authenticated SGLS command link
- communications between bus and encrypters will be via redundant serial output buffers (SOBs), similar to CIU/PIP interface (unique command followed by data words and execute)
- CIU will require modifications to add redundant SOBs (no spares available)

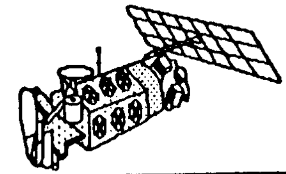
LONG-TERM ENCRYPTION APPROACH





FREQUENCY ALLOCATION

FREQUENCY ALLOCATION PROCESS



- Radio frequency assignments are governed by AFR 700-14

- Frequency allocation proposals are submitted to the Space Systems Division Frequency Manager via the PCO, using DD Form 1494 and FCC Form 130

- Proposals are reviewed by the Joint Frequency Panel

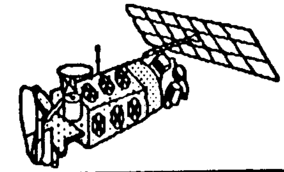
- Need contact at SSD/DC (Communications - Electronics Support Office)

Dave Weiss working

TRADEOFFS

SWH = s/c Wire Harness

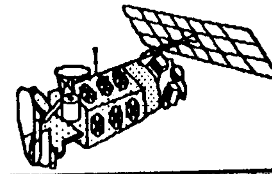
TRADEOFF MATRIX



	S-BAND DIGITAL		VHF/UHF DIGITAL	VHF ANALOG (APT)
SPACE SEGMENT	**APP. #1 & #2**	**APPROACH #3**		
HARDWARE REQUIREMENTS				
• NEW UNITS	ENCRYPTER	XMTRS; ANTENNA; ENCRYPTER	XMTRS; ANTENNA; ENCRYPTER	XMTRS; ANTENNA; ~~ENCRYPTER~~
- POWER	10 W	38 W	31.2 W	22.1 W
- SIZE/WEIGHT	3.7 LBS	9.9 LBS	11 LBS	9.6 LBS
• MODIFIED UNITS	SWH; OSU	SWH; OSU; SPS	SWH; CIU; OLS SPS; OSU	HARNESS; CIU; OLS SPS
ENCRYPTION	FEASIBLE	FEASIBLE	FEASIBLE	NOT FEASIBLE
MISSION SENSOR DATA	AVAILABLE	AVAILABLE	AVAILABLE	NOT AVAILABLE
FREQUENCY ALLOCATION	NOT DIFFICULT	NOT DIFFICULT	DIFFICULT	DIFFICULT
COST	LOW	LOW	MODERATE	EXPENSIVE
SCHEDULE	S11 AND UP	S14 AND UP	S14 AND UP	S16 AND UP
GROUND SEGMENT				
ANTENNA COMPLEXITY	COMPLEX, STEERABLE		SIMPLE, OMNIDIRECTIONAL	SIMPLE, OMNIDIRECTIONAL
PERFORMANCE				
• GRIDDING	DERIVED FROMTRANSMITTED EPHEMERIS		DERIVED FROM TRANSMITTED EPHEMERIS	EMBEDDED IN IMAGE
• RESOLUTION	SAME AS SDS		SAME AS SDS	SAME AS TIROS APT
EASE OF USE	MODERATE		SIMPLE	SIMPLE
COST	EXPENSIVE		MODERATE	LOW

* DOES NOT INCLUDE ANTENNA

~200# ~100#



RECOMMENDATIONS

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RECEIVING TERMINAL RECOMMENDATIONS FOR THE NEAR TERM (EVALUATION PHASE)

- DEVELOP LANDBASED AND SHIPBOARD PROTOTYPE RDS RECEIVING SYSTEMS:

BASELINE APPROACH:

-DIGITAL RDS AT 2267.5 MHz (PDT-2), BPSK MODULATION

ANTENNA :

-USE TWO FOOT DISH ON OFF-THE-SHELF AZ-EL POSITIONER

-MOUNT LANDBASED VERSION ON TRIPOD FOR FIELD DEPLOYMENT

-MOUNT SHIPBOARD VERSION ON ROLL-STABILIZED PLATFORM

-INTERFACE SHIPBOARD VERSION WITH SHIP'S INERTIAL NAVIGATION SYSTEM

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RECEIVING TERMINAL RECOMMENDATIONS FOR THE NEAR TERM (EVALUATION PHASE)

- **DEVELOP LANDBASED AND SHIPBOARD PROTOTYPE RDS RECEIVING SYSTEMS (CONT):**

RDS FORMATTER AND MONITOR:

-DEVELOP INTEGRATED DEMOD / BIT SYNC ON A CARD

-DEVELOP DEINTERLEAVER / FRAME SYNC / DECOM CARD

-USE OFF-THE-SHELF TEMPEST PC/AT PROCESSOR WITH ENHANCED VGA GRAPHICS (640X480)

-USE OFF-THE-SHELF HIGH RESOLUTION MONITOR

-DRIVE WRAASE UNITS WITH OFF-THE-SHELF FACSIMILE OUTPUT CARD

CRYPTO:

-USE GFE KG-44 CRYPTO

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RECEIVING TERMINAL RECOMMENDATIONS FOR THE LONG TERM (OPERATIONAL PHASE)

•DEVELOP LANDBASED AND SHIPBOARD OPERATIONAL RDS RECEIVING SYSTEMS:

BASELINE APPROACH:

-DIGITAL RDS AT VHF OR UHF, BPSK MODULATION, CONVOLUTIONAL CODING (R=1/2, K=7)

for error correction

ANTENNA:

-REPLACE S-BAND ANTENNA AND POSITIONER WITH VHF OR UHF OMNIDIRECTIONAL ANTENNA

-REMOVE ROLL-STABILIZED PLATFORM AND SINS INTERFACE FROM SHIPBOARD INSTALLATIONS

RDS FORMATTER AND MONITOR:

-RETAIN FORMATTER AND MONITOR

-DELETE ANTENNA POINTING INTERFACE (AND S/D CARD IF INSTALLED)

-ADD VITERBI ERROR CORRECTION TO THE DEMOD/BIT SYNC

CRYPTO:

-INCORPORATE NEW RICEBIRD CRYPTO (GFE) IF AVAILABLE

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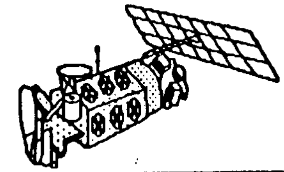
ALTERNATIVES FOR USE OF CURRENT INVENTORY ITEMS DURING EVALUATION PHASE

Test Weather System

TWO APPROACHES FOR DISCUSSION AS EVALUATION-PHASE ALTERNATIVES:

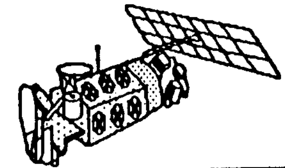
- INCORPORATE RDS RECEIVING FUNCTIONS INTO THE IMETS/TWS SYSTEM

- USE THE STANDALONE RDS RECEIVING SYSTEM AS A FRONT-END FOR THE IMETS/TWS SYSTEM



GOALS & OBJECTIVES FOR PROGRESS BRIEFING # 3

GOALS/ OBJECTIVES FOR PROGRESS BRIEFING #3



- Space Segment
  - Present qualification plans for new/modified satellite hardware
  - Present component and satellite level test plans
  - Present Rough-Order-Of-Magnitude cost and schedule estimates for each approach considered
  - Generate final Technical Operating Report

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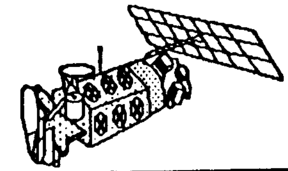
GOALS/OBJECTIVES FOR PROGRESS BRIEFING #3

-GROUND SEGMENT

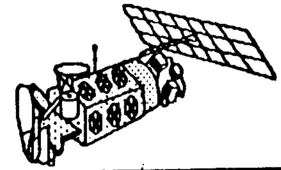
- GENERATE A FUNCTIONAL SPECIFICATION — Contingent upon selection of long term
- PREPARE A COST AND SCHEDULE ROM FOR EACH OPTION
  - NRE
  - RE
  - BASELINE AT 20 GROUND SYSTEMS
  - ADDRESS SHIPBOARD APPLICATION DELTA
  - ASSUME A TEMPEST REQUIREMENT FOR FORMATTER
  - ASSUME MINIMAL CDRL COMPLEMENT
  - ASSUME KG EQUIPMENT IS GFE
- GENERATE FINAL TECHNICAL OPERATING REPORT



OPEN ISSUES

Adams: Look at both S-band
& VHF/UHF simultaneously
i.e. Army looking @ VHF (transportabili
A.F. " S-band (RFI/JAM

OPEN ISSUES



- SPO selection of operational approach needed today in order for functional specification to be generated before task period-of-performance expires

- SPO is requested to find contact at SSD/DC as source of information on frequency allocation

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REALTIME DATA SMOOTH (RDS) LINK BUDGET SUMMARY

CASE	REQUIRED RECEIVING ANTENNA GAIN	RECEIVING ANTENNA SIZE
1. 2237.5 MHz, SPACECRAFT OMNI ANT, 1.024 MHz SUBCARRIER	25.1 dB	4.0 FEET
2. 2237.5 MHz, SPACECRAFT DIRECTIONAL ANT, 1.024 MHz SUBCARRIER	18.3 dB	1.8 FEET
3. 2267.5 MHz, SPACECRAFT DIRECTIONAL ANT, DIRECT MODULATION	15.4 dB	1.3 FEET
4. 2267.5 MHz, SPACECRAFT DIRECTIONAL ANT, DIRECT MODULATION, CONVOLUTIONAL CODING	10.4 dB	<1 FOOT
5. 137.5 MHz, TIROS ANTENNA, DIRECT MODULATION, CONVOLUTIONAL CODING	-3.7 dB	OMNI
6. 225 MHz, TIROS-LIKE ANTENNA, DIRECT MODULATION, CONVOLUTIONAL CODING	-3.4 dB	OMNI

NOTE THAT THE S-BAND APPROACHES ALL REQUIRE DIRECTIONAL (STEERABLE) RECEIVING ANTENNAS

S-BAND DIGITAL APPROACH EVALUATION CRITERIA

- SATELLITE COMPLEXITY
- RECEIVING SYSTEM COMPLEXITY
- AVAILABILITY OF MISSION SENSOR DATA
- FEASIBILITY OF ENCRYPTION
- RESOLUTION OF IMAGERY
- DIFFICULTY OF OBTAINING FREQUENCY ALLOCATION
- SUSCEPTIBILITY TO RADIO FREQUENCY INTERFERENCE (RFI)
- SUSCEPTIBILITY TO JAMMING

NOTE: THE SAME EVALUATION CRITERIA ARE USED FOR ALL APPROACHES

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ALTERNATIVES PREVIOUSLY PURSUED DURING RDS STUDY

NUMEROUS ALTERNATIVES WERE EXPLORED DURING THE COURSE OF THE STUDY. APPROACHES CONSIDERED BUT NOT ADOPTED INCLUDE THE FOLLOWING:

- A NON-ENCRYPTED DEMONSTRATION SYSTEM
- RDS TRANSMISSION BY MEANS OF SGLS SUBCARRIER
- USE OF THE WRAASE RECEIVER'S DIGITAL INPUT PORT
- IESS-309 SATCOM MODEMS FOR THE VHF/UHF DIGITAL APPROACH
- AN AUTOTRACKING ANTENNA FOR THE RECEIVING TERMINAL
- PHASED ARRAY RECEIVING ANTENNAS
- GRIDDING APPROACHES BASED ON USE OF NORAD EPHEMERIS DATA
- GRIDDING OF DMSP APT DATA WITHIN THE RECEIVING EQUIPMENT

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RECEIVING TERMINAL CRYPTO UNIT

- STAND ALONE MULTIPLE KEY GENERATOR (SAM-KG) NOW UNDER DEVELOPMENT
- SAM-KG ENGINEERING DEVELOPMENT MODELS AVAILABLE WITHIN ONE YEAR
- OVERCOMES RECEIVING TERMINAL CRYPTO AVAILABILITY PROBLEMS
- AVOIDS COST OF DEVELOPING NEW RECEIVING TERMINAL CRYPTO
- RICEBIRD-BASED
- COMPATIBLE WITH KG-46 ALGORITHM AND FUTURE SPACECRAFT CRYPTOS
- FOUR CHANNEL UNIT CAN BE DEPOPULATED FOR SINGLE CHANNEL USE
- PACKAGING IS 3/4 ATR BOX (7" X 7" X 12")
- WEIGHT: 25 POUNDS
- AC POWER: 40 WATTS

PROGRESS SINCE BRIEFING #2

- IDENTIFIED A MUCH LESS COMPLEX, MUCH LIGHTER ANTENNA POSITIONER FOR USE IN THE S-BAND APPROACHES

- REPLACED THE ROLL-STABILIZED PLATFORM USED IN SHIPBOARD S-BAND APPROACHES WITH A LESS EXPENSIVE UNIT CONTAINING AN INTERNAL VERTICAL REFERENCE GYRO AND CAPABLE OF BOTH PITCH AND ROLL STABILIZATION

- IDENTIFIED A RICEBIRD-BASED RECEIVE-ONLY CRYPTO, PRESENTLY UNDER DEVELOPMENT, THAT COULD REPLACE THE HARD-TO-FIND OLDER GROUND CRYPTOS

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CHANGES RESULTING FROM BRIEFING #2

- BECAUSE OF HEIGHTENED CONCERNS ABOUT RFI AND JAMMING, AN S-BAND APPROACH IS NOW RECOMMENDED FOR THE OPERATIONAL SYSTEM

- VITERBI ERROR CORRECTION HAS BEEN ADDED TO THE DESIGN BASELINE FOR THE S-BAND APPROACHES

  -ERROR CORRECTION CAN BE BYPASSED DURING DEMO PHASE

- THE KG-46/KG-28 ALGORITHM HAS REPLACED THE KG-43/KG-44 ALGORITHM AS THE ENCRYPTION APPROACH

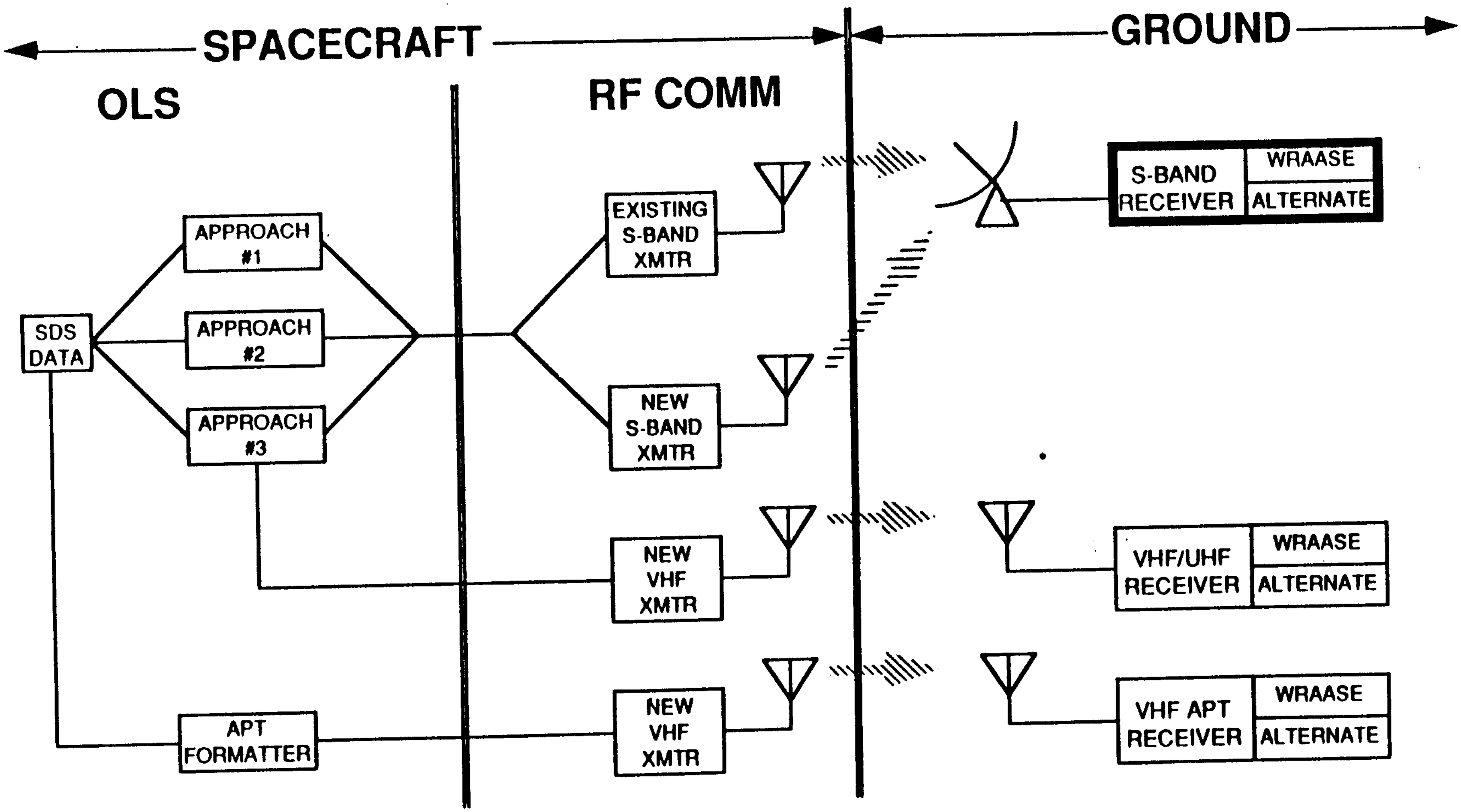
  -THIS DECISION IS DRIVEN BY THE AVAILABLE SPACECRAFT CRYPTO

- THE 80286-BASED PROCESSOR IN THE RDS FORMATTER HAS BEEN REPLACED BY AN 80386-BASED PROCESSOR

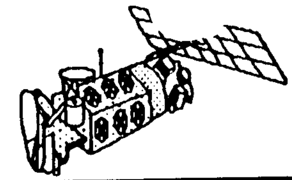
  -THIS FACILITATES LATER ADDITION OF SPECIAL SENSOR PROCESSING OR OTHER ENHANCEMENTS

32 bit

GROUND - S-BAND



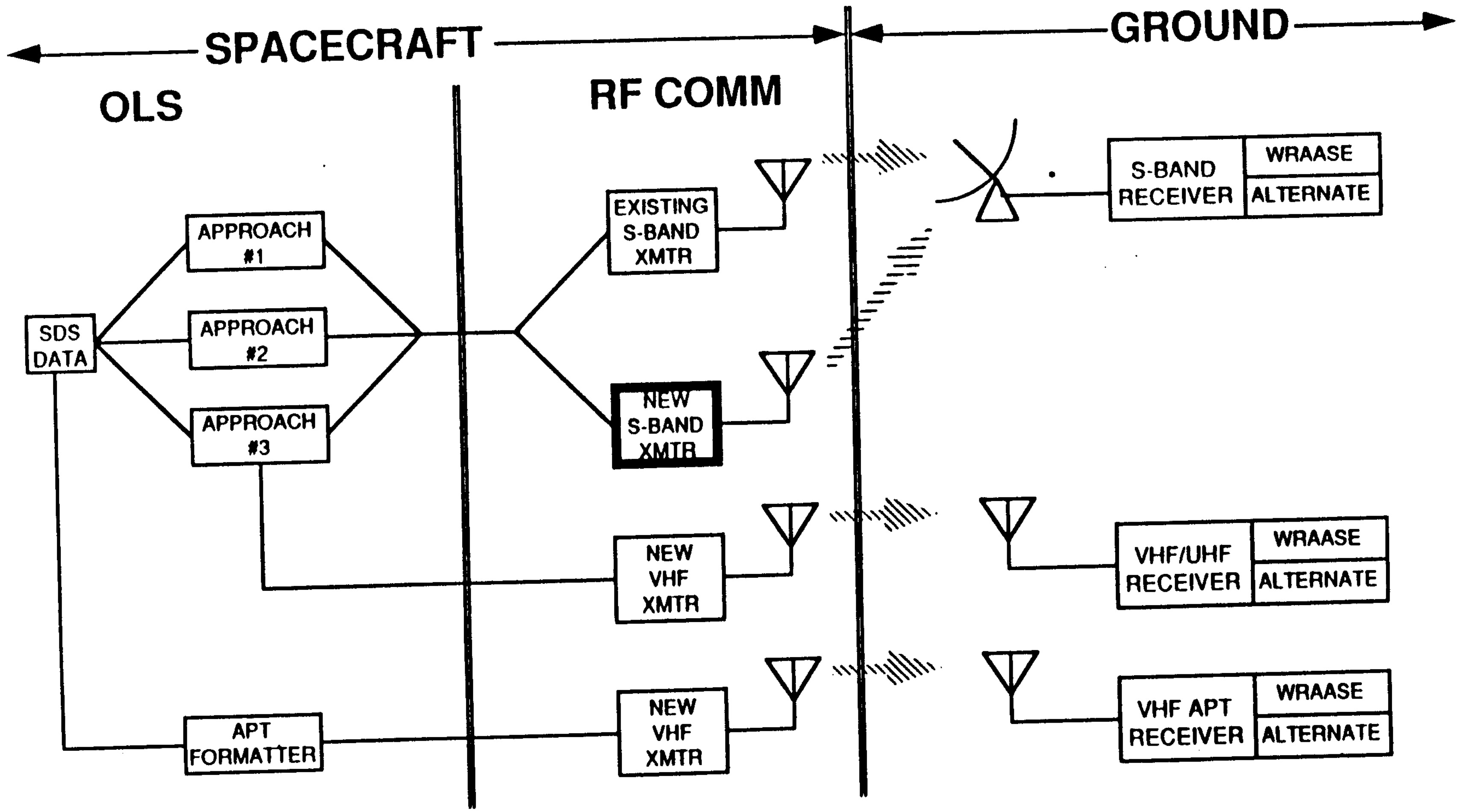
SPACECRAFT RF COMMUNICATIONS



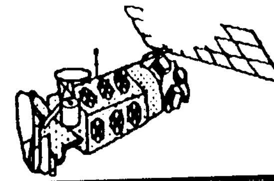
NEW S-BAND APPROACH

- Present transmitter and antenna designs can be used with tuning to optimize performance at chosen carrier frequency
- Design modifications to the CIU, PIP, OSU, SPS, and harness are required
- Dedicated transmitters, RF switch, and antenna will be added

RF COMMUNICATIONS - NEW S-BAND



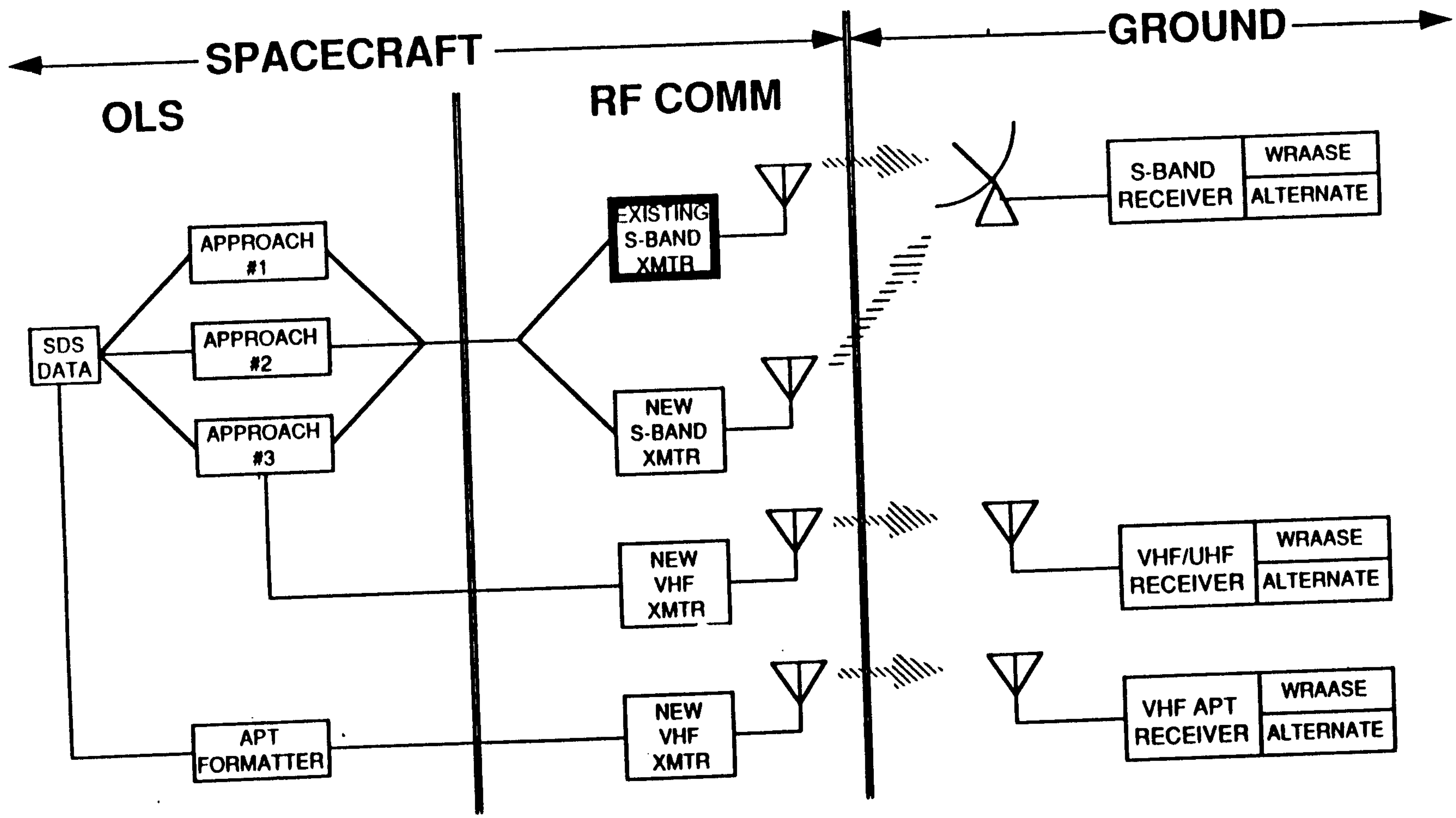
SPACECRAFT RF COMMUNICATIONS



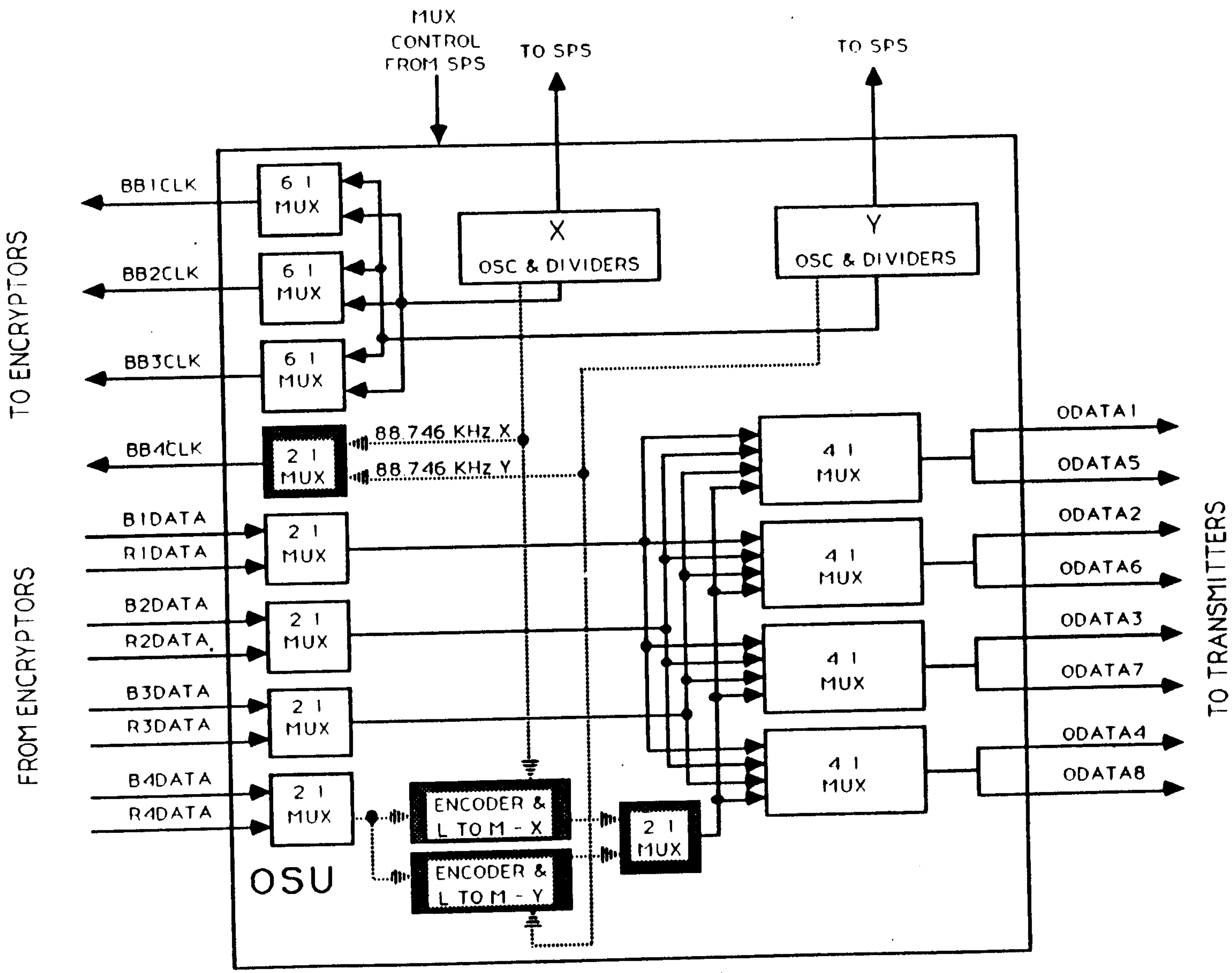
EXISTING S-BAND APPROACH

- No modifications necessary to present spacecraft communications hardware
- Existing transmitter design compatible with RDS data rate (66.56 or 88.746 Kbps)
- PDT-2 chosen because its use would create the least amount of conflict with the present operational system (although capability would exist to supply RDS data to any of the transmitters)
- One stored data link must be pre-empted whenever it is desired to transmit RDS within CRS station circle
- Real time data (RTD) not affected

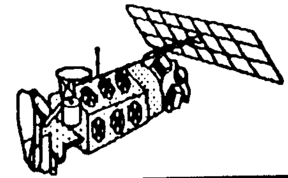
RF COMMUNICATIONS - EXISTING S-BAND



DIGITAL APPROACH #3
OSU MODIFICATIONS

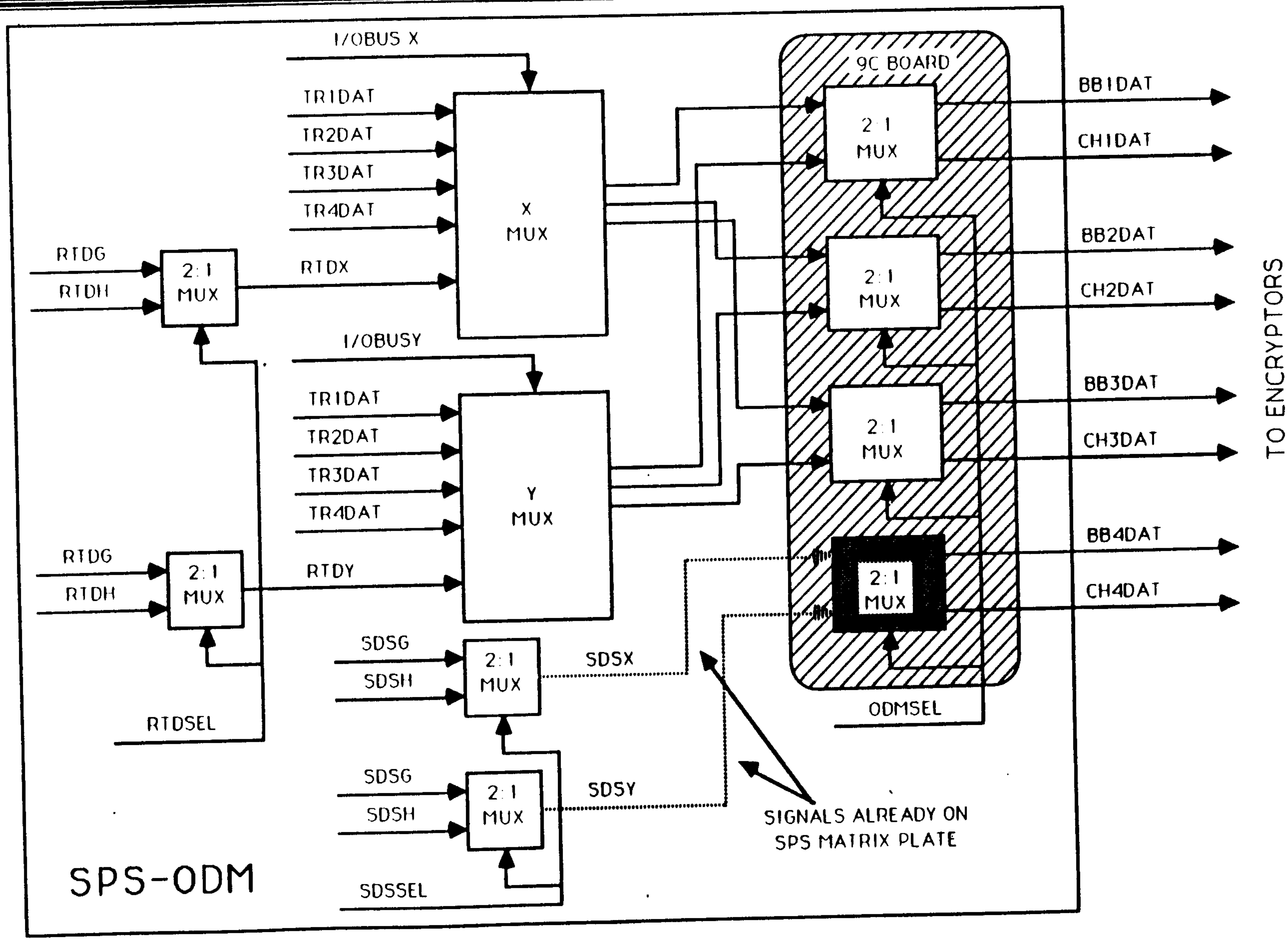


DIGITAL APPROACH #3
OSU MODIFICATIONS

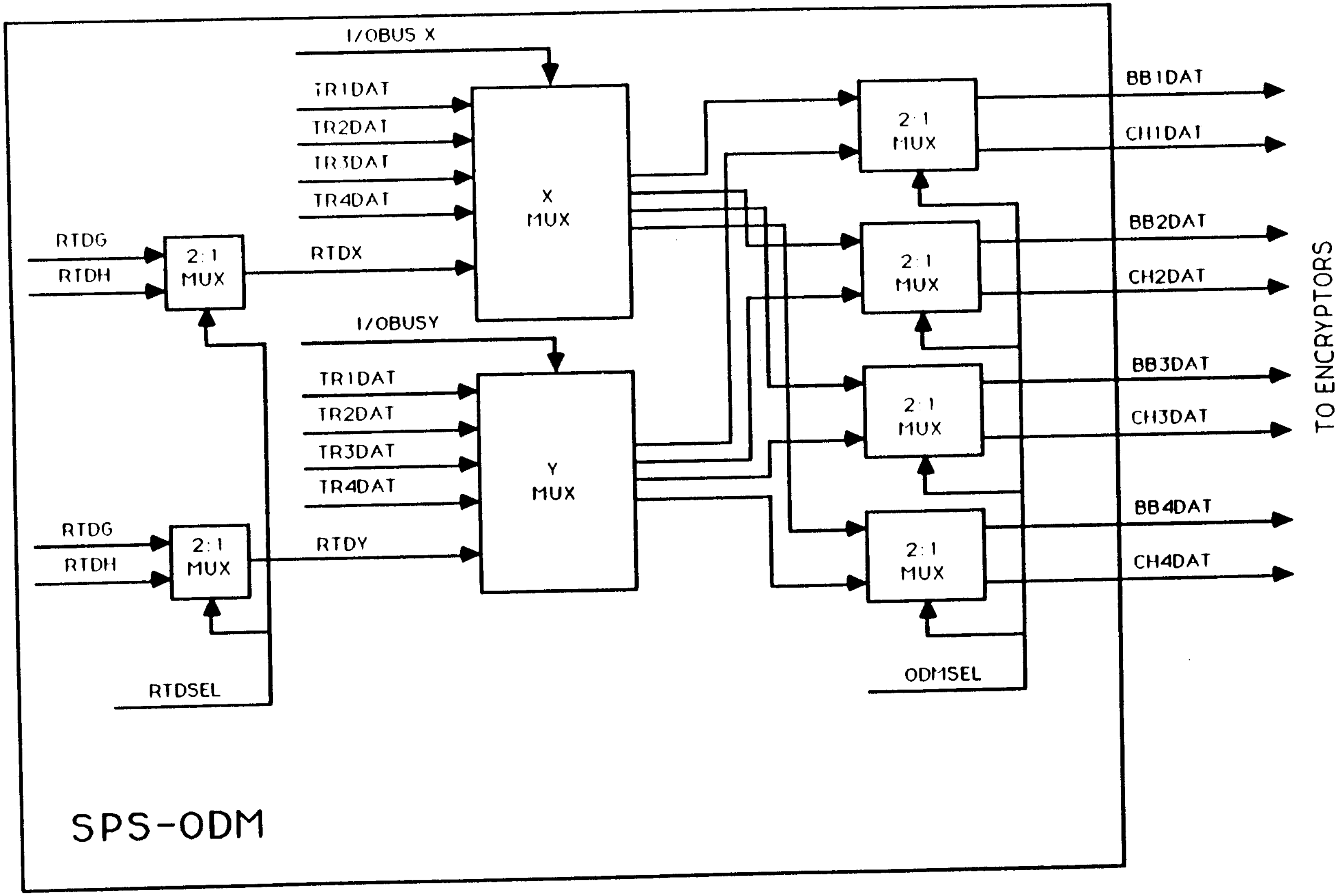


- DIGITAL APPROACH #3 WILL REQUIRE THE FOLLOWING MODIFICATIONS TO THE OSU AND ITS TWO BOARD ASSEMBLIES
  - NEW CLOCK DIVIDER MUST BE ADDED TO PROVIDE 66.5 OR 88.746 KHZ CLOCK TO ENCRYPTER AND RATE 1/2 ENCODER
  - CIRCUITRY MUST BE ADDED TO ENCODE THE DATA USING A 7 POLYNOMIAL RATE 1/2 ALGORITHM
  - CONVERT DATA FROM NRZ-L TO NRZ-M
  - MODIFY MULTIPLEXING SCHEME TO DEDICATE ENCRYPTER-4 TO RDS
  - MATRIX PLATE MUST BE MODIFIED TO REROUTE SIGNALS
- RATE 1/2 ENCODED NRZ-M RDS DATA WILL BE AVAILABLE TO ANY TRANSMITTER ATTACHED TO THE OSU (S-BAND, VHF OR UHF)

DIGITAL APPROACH #3
ODM MODIFICATIONS



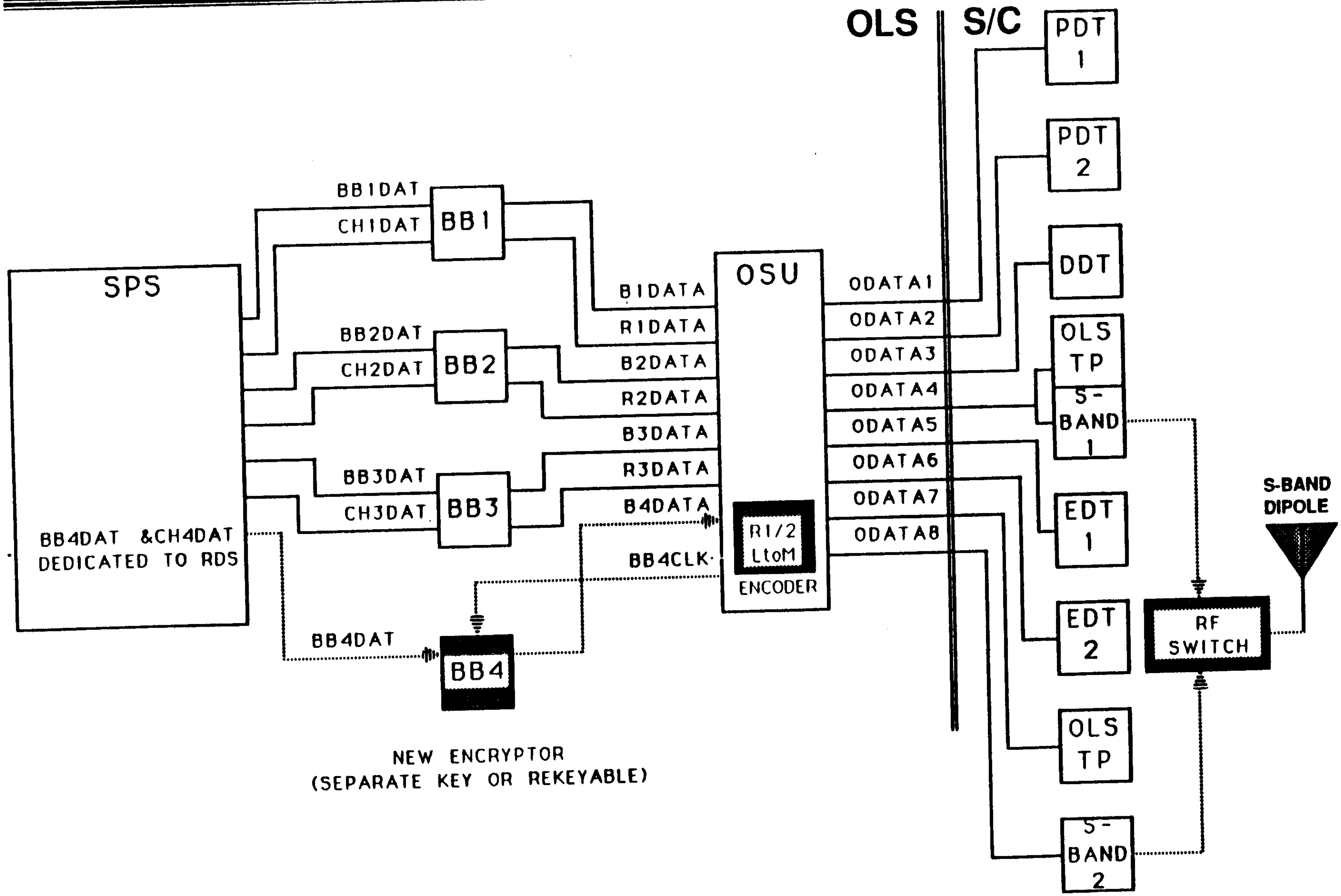
CURRENT OLS OUTPUT DATA MUX



DIGITAL APPROACH #3
SPS MODIFICATIONS

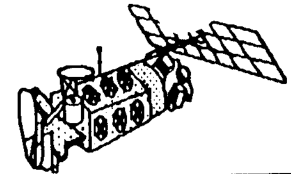
- DIGITAL APPROACH #3 WILL REQUIRE THE FOLLOWING MODIFICATIONS TO THE SPS
  - MATRIX PLATE MUST BE MODIFIED TO ROUTE SDS DATA TO THE 9C OUTPUT DATA MUX BOARD
  - MODIFY 9C BOARD TO MULTIPLEX THE SDSX AND SDSY DATA TO THE ENCRYPTER THROUGH BB4DAT AND CH4DAT
- A REKEYABLE ENCRYPTER MAY REQUIRE ADDITIONAL MODIFICATIONS TO THE SPS TO PROVIDE COMMUNICATION BETWEEN THE OLS PROCESSOR AND THE ENCRYPTER

DIGITAL APPROACH #3
OLS MODIFICATIONS



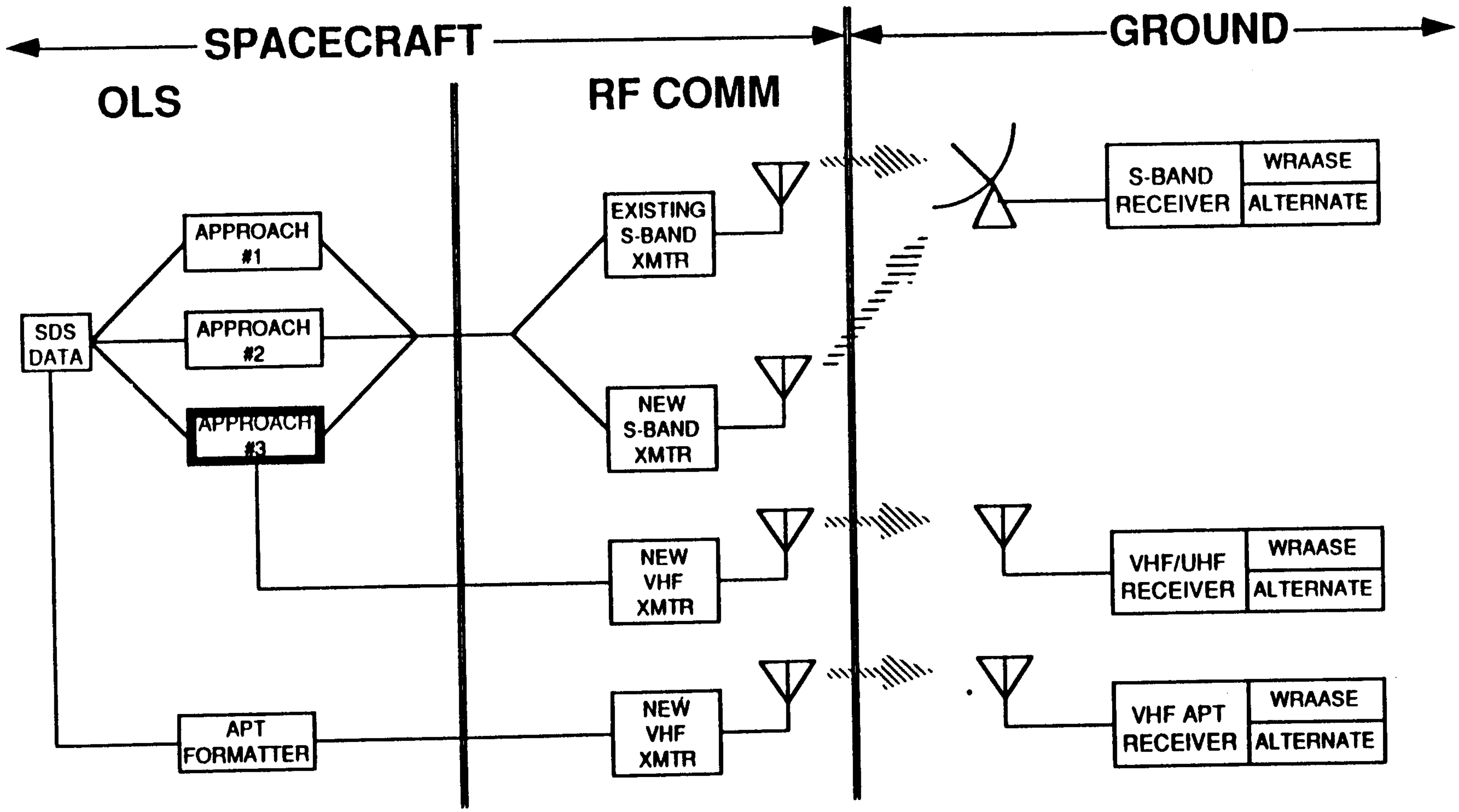
NEW ENCRYPTOR
(SEPARATE KEY OR REKEYABLE)

DIGITAL APPROACH #3
OLS OVERVIEW

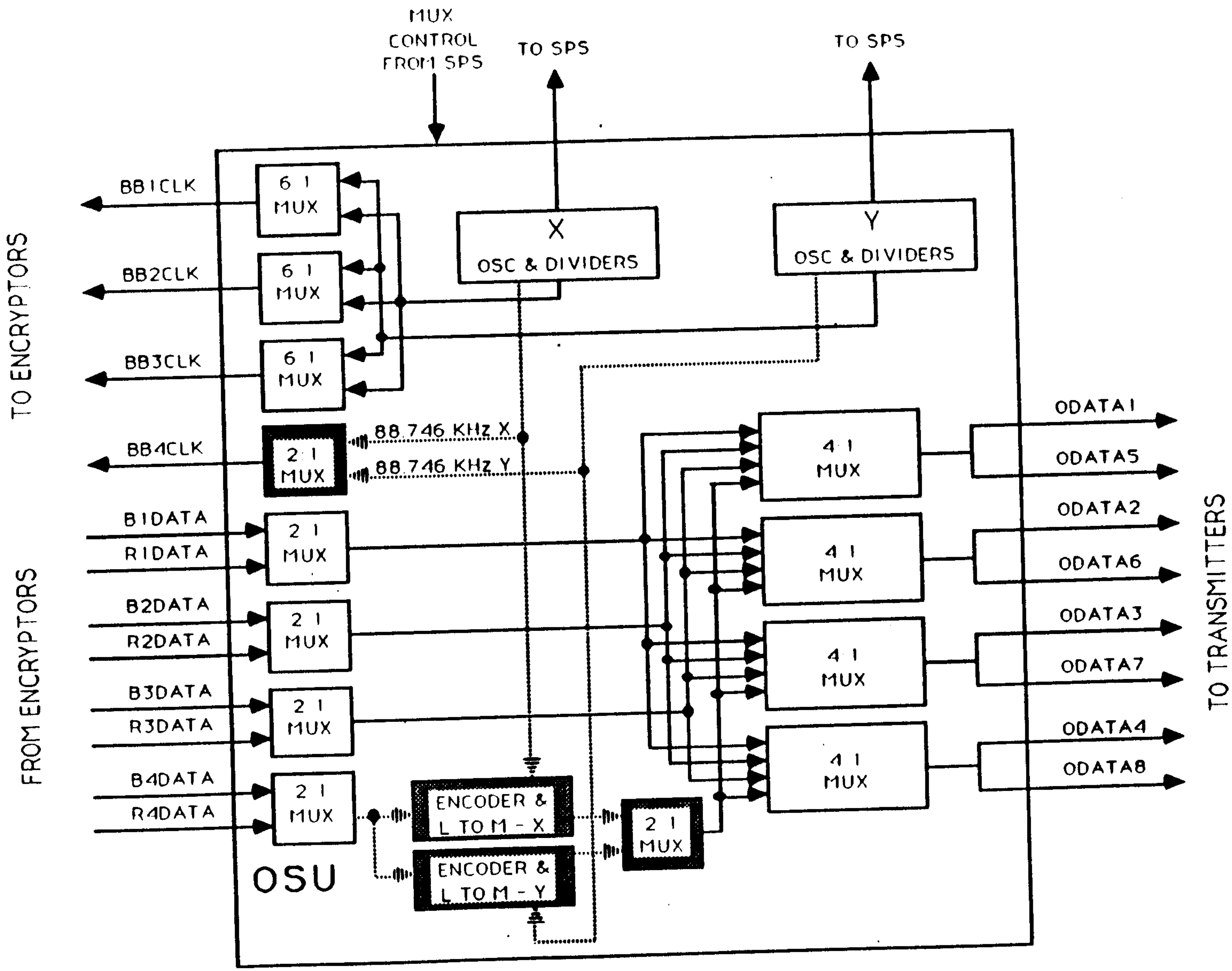


- THE DIGITAL APPROACH #3 WILL REQUIRE MODIFICATIONS TO THE SPS AND OSU TO PROVIDE A CLEAN PERMANENT INTERFACE BETWEEN THE SPS, ENCRYPTER, OSU AND TRANSMITTER
- SPS WILL BE MODIFIED TO DEDICATE DATA LINES BB4DAT AND CH4DAT TO THE RDS STREAM
- A NEW ENCRYPTER, EITHER REKEYABLE OR WITH A KEY DIFFERENT FROM THE PRIMARY DATA ENCRYPTERS WILL BE DEDICATED TO RDS
    - THE OLS ALREADY HAS LINES TO CONTROL A FOURTH ENCRYPTER
- OSU WILL BE CHANGED TO:
    - PROVIDE A 66.5 OR 88.746 KHZ CLOCK TO NEW ENCRYPTER
    - "RATE 1/2" ENCODE RDS WITH 7 POLYNOMIAL ALGORITHM
    - CONVERT NRZ-L TO NRZ-M
- SENSOR APPROACH REMAINS THE SAME REGARDLESS OF THE TYPE OF TRANSMITTERS (S-BAND, VHF OR UHF) ATTACHED TO THE OSU
- APPROACH #3 PROVIDES A REDUNDANT DATA PATH ALLOWING RDS DATA FROM EITHER FORMATTER G OR H TO BE TRANSMITTED

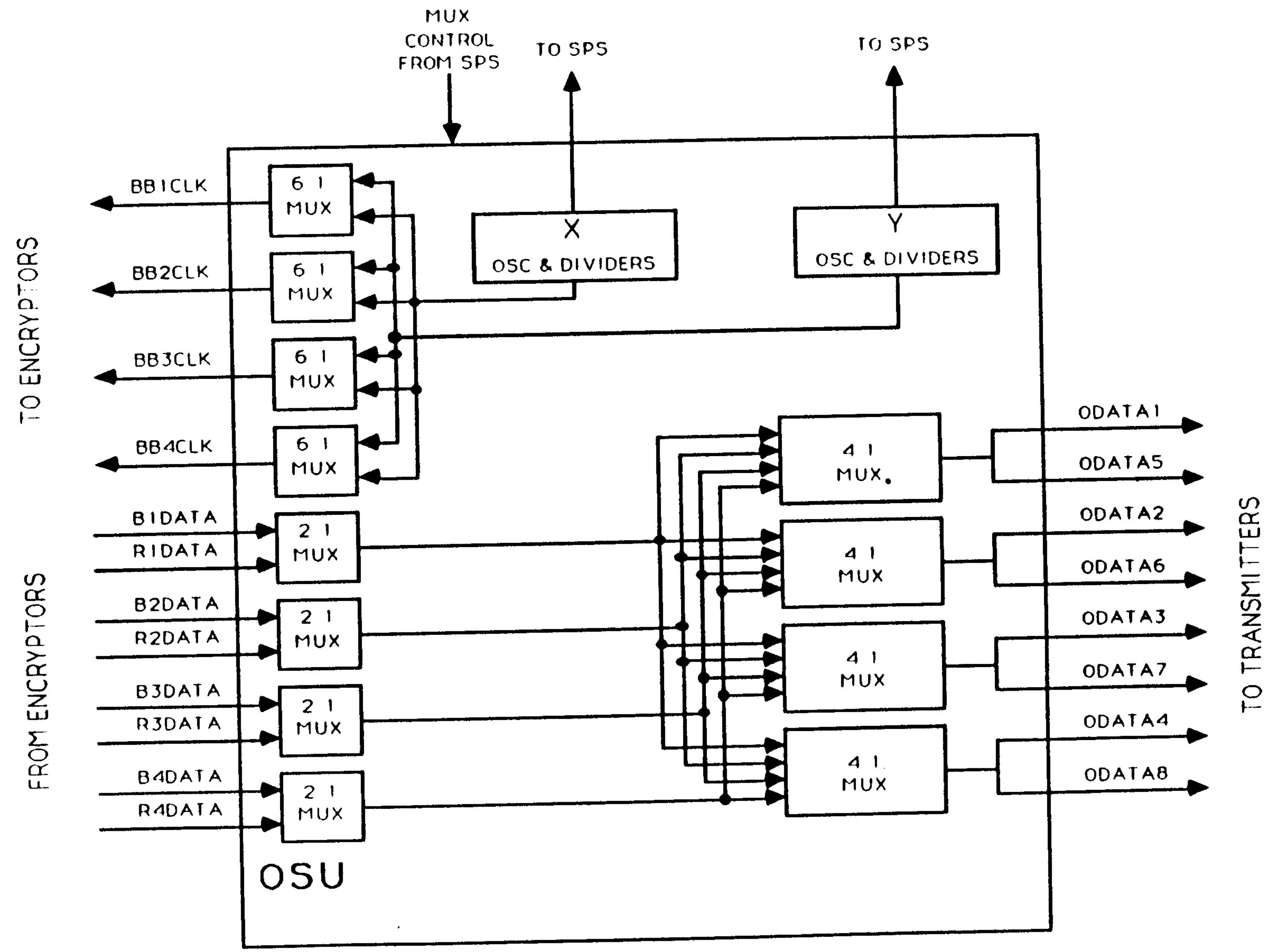
OLS APPROACH #3



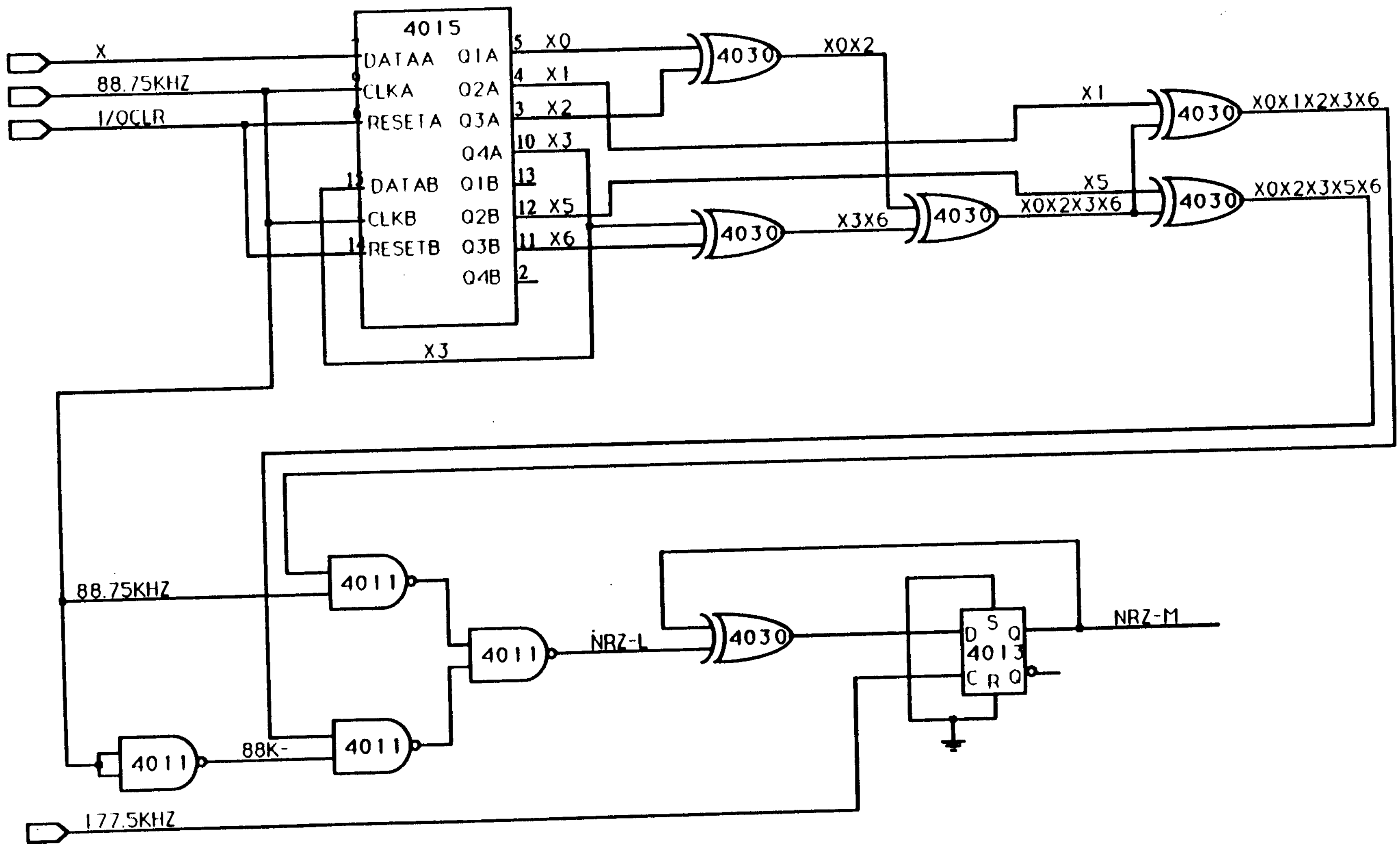
DIGITAL APPROACH #2
OSU MODIFICATIONS



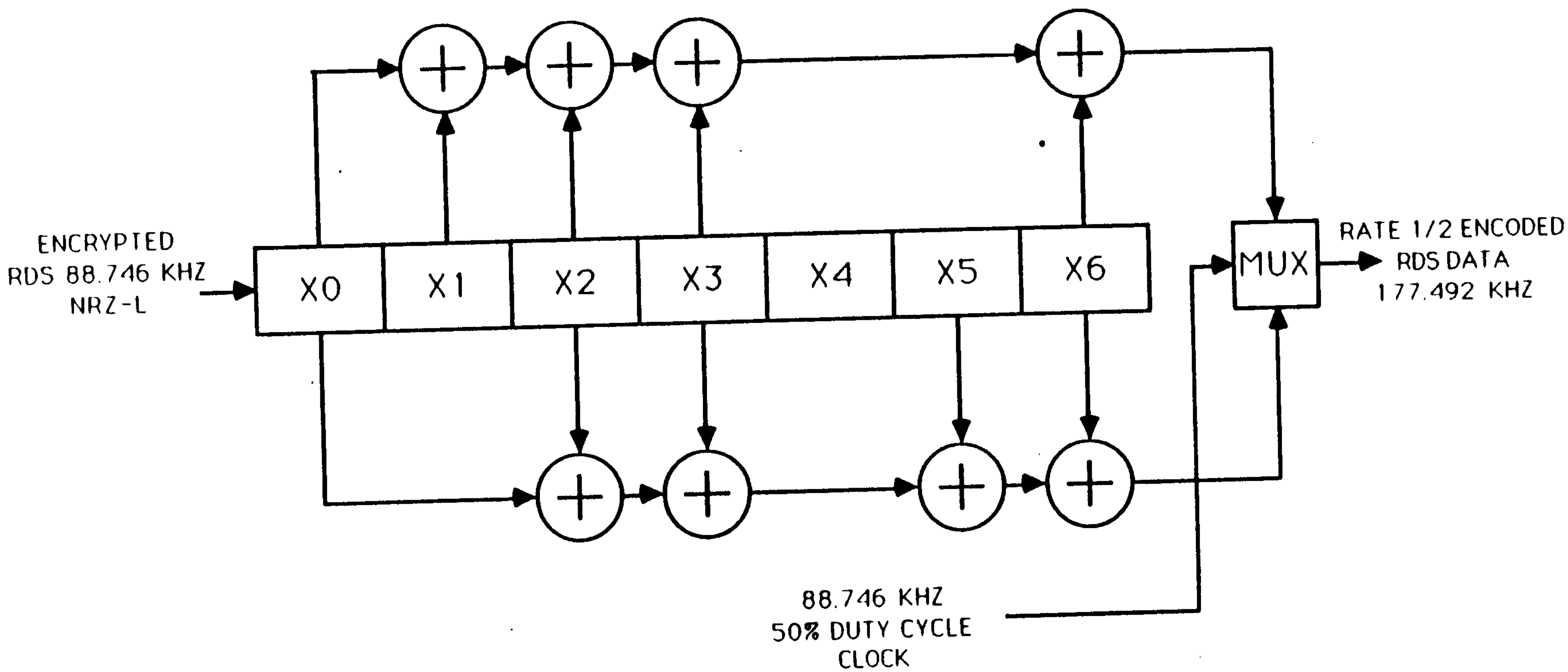
CURRENT OLS OUTPUT SWITCHING UNIT



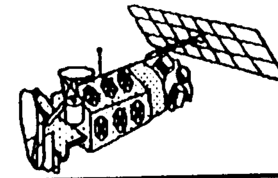
RATE 1/2 ENCODER & NRZ CONVERTER



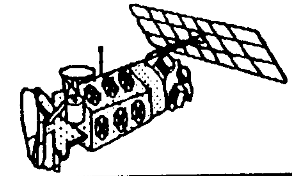
RATE 1/2 ENCODER ALGORITHM



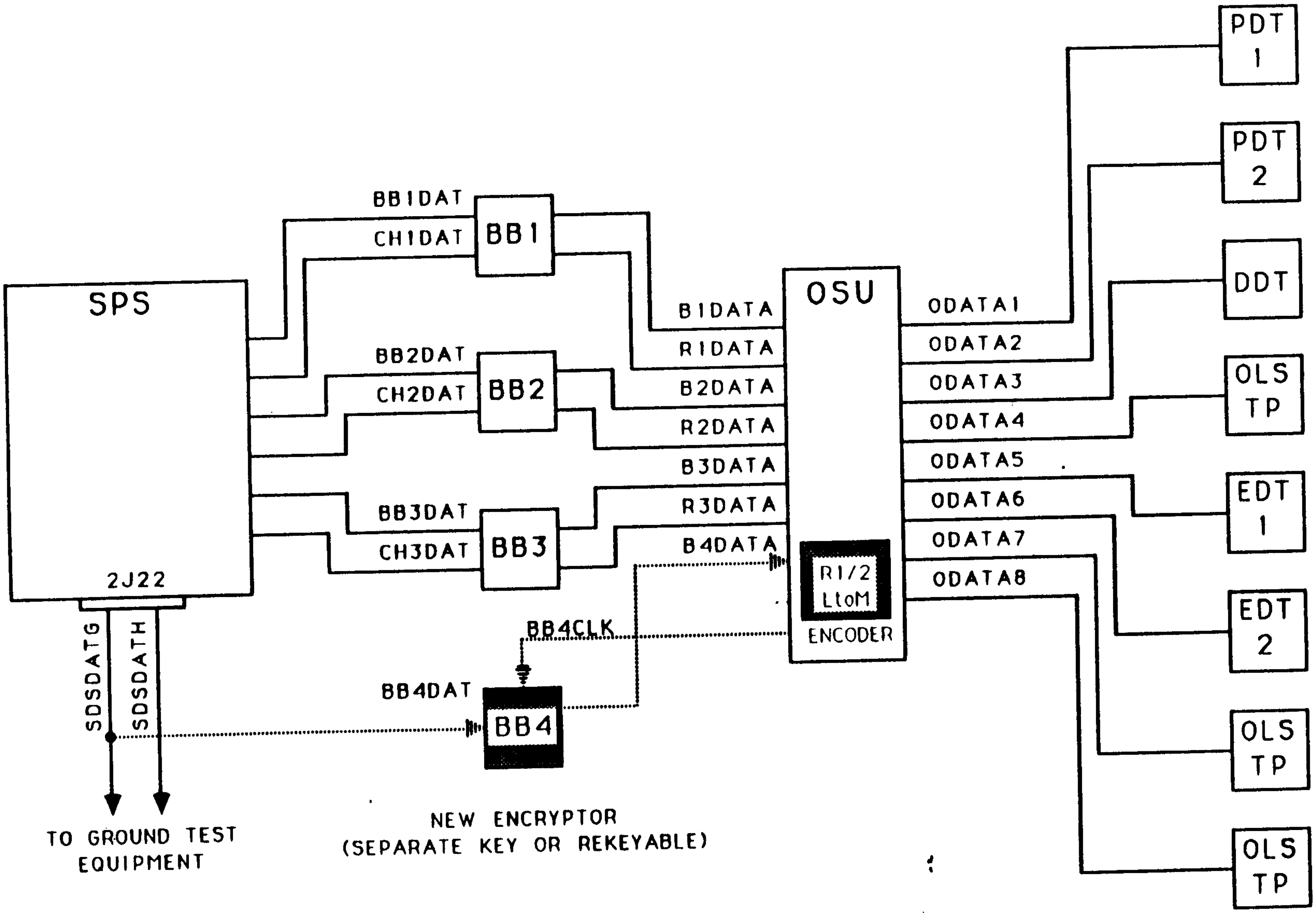
RATE 1/2 ENCODER ALGORITHM



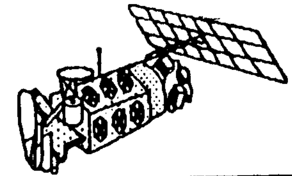
- TO INCREASE LINK MARGIN, THE ENCRYPTED REAL-TIME DATA SMOOTH IS REPROCESSED IN THE OSU
  - THE NRZ-L DATA FROM THE ENCRYPTER IS RATE 1/2 ENCODED WITH A 7 POLYNOMIAL CONVOLUTIONAL CODE
  - THE ENCODED NRZ-L DATA IS THEN CONVERTED TO NRZ-M
- CURRENTLY THERE IS ENOUGH SPACE IN THE OSU FOR APPROXIMATELY 34 16-PIN INTEGRATED CIRCUITS
- IT WILL TAKE AN ESTIMATED 5 INTEGRATED CIRCUITS TO DO THE ENCODING AND CONVERSION PER SIDE (10 TOTAL), AND ANOTHER 4 PARTS PER SIDE TO CREATE THE 66.5 OR 88.746 KHZ CLOCK (8 TOTAL)



DIGITAL APPROACH #2
OLS MODIFICATIONS

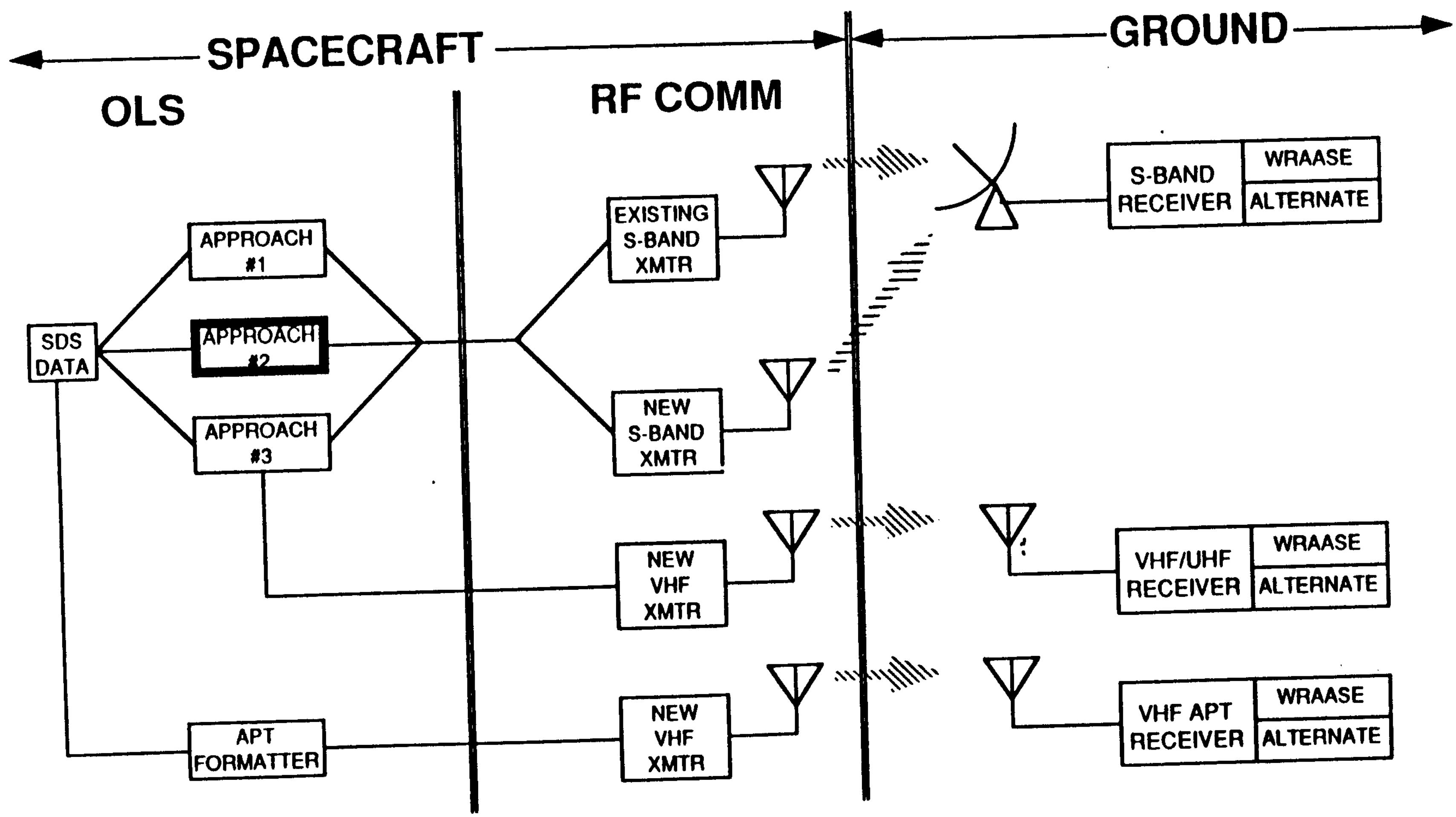


DIGITAL APPROACH #2
OLS OVERVIEW

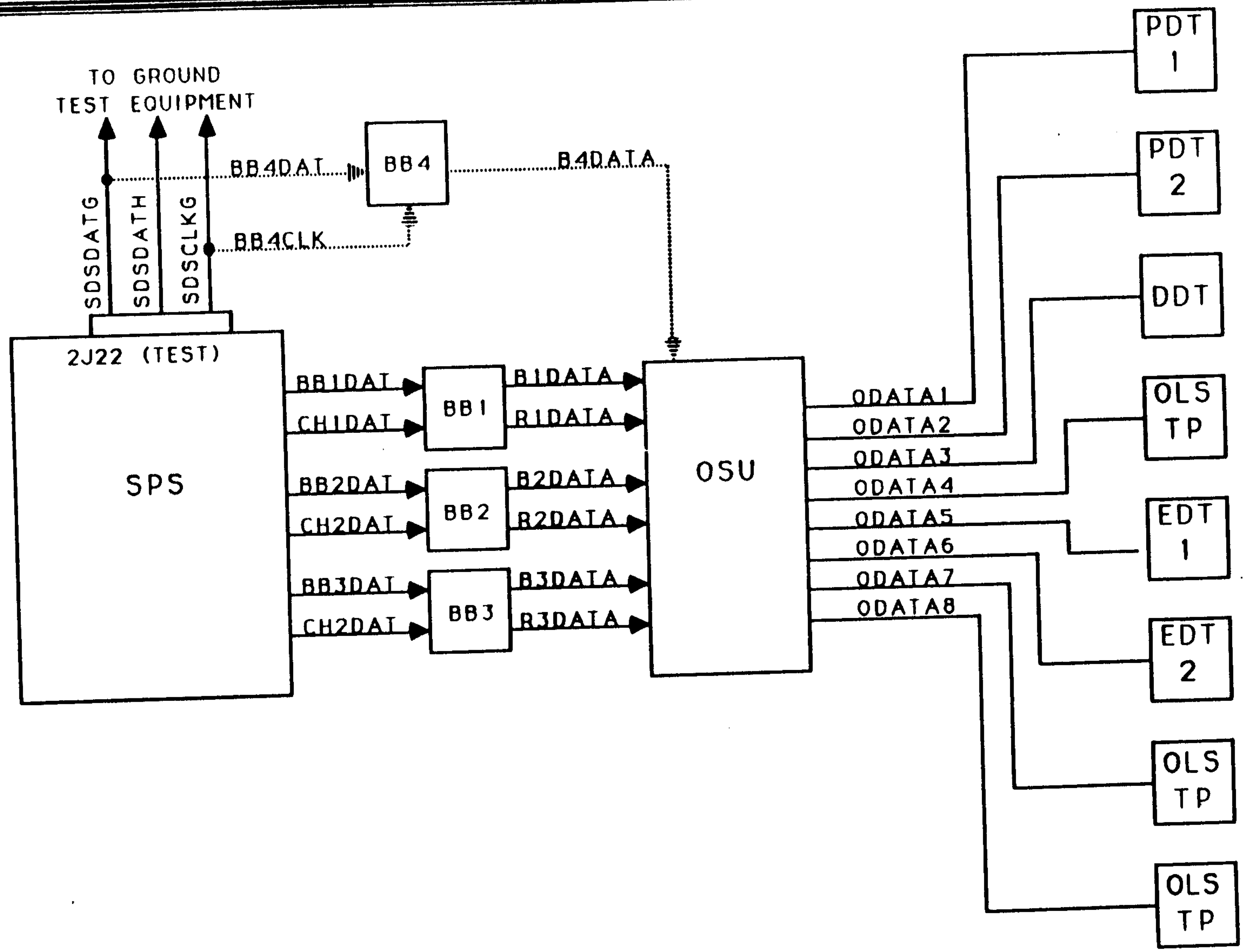


- DIGITAL APPROACH #2 REQUIRES MODIFICATIONS TO THE OSU
  - SMOOTH DATA FROM FORMATTER G IS AVAILABLE ON A TEST CONNECTOR USED FOR GROUND TESTING
  - IN OPERATION SDS-G WOULD BE ATTACHED TO A NEW KG-46 ENCRYPTER, AND THE ENCRYPTER OUTPUT CONNECTED TO B4DATA ON A MODIFIED OSU
  - THE OSU WOULD RATE 1/2 ENCODE, CONVERT THE DATA FROM NRZ-L TO NRZ-M, ROUTE THE SMOOTH DATA TO THE APPROPRIATE TRANSMITTER, AND PROVIDE THE CLOCK TO THE NEW ENCRYPTER
  - THE OLS CURRENTLY HAS CONTROL LINES FOR A FOURTH ENCRYPTER
  - OPERATIONAL CONSTRAINT - ENCRYPTED DATA WOULD BE AVAILABLE ONLY FROM FORMATTER-G WITH NO REDUNDANT DATA PATH

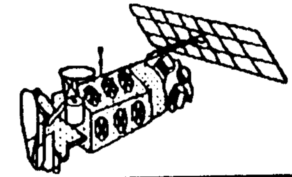
OLS APPROACH #2



DIGITAL APPROACH #1
ENCRYPTION

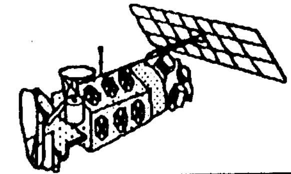


DIGITAL APPROACH #1
ENCRYPTION



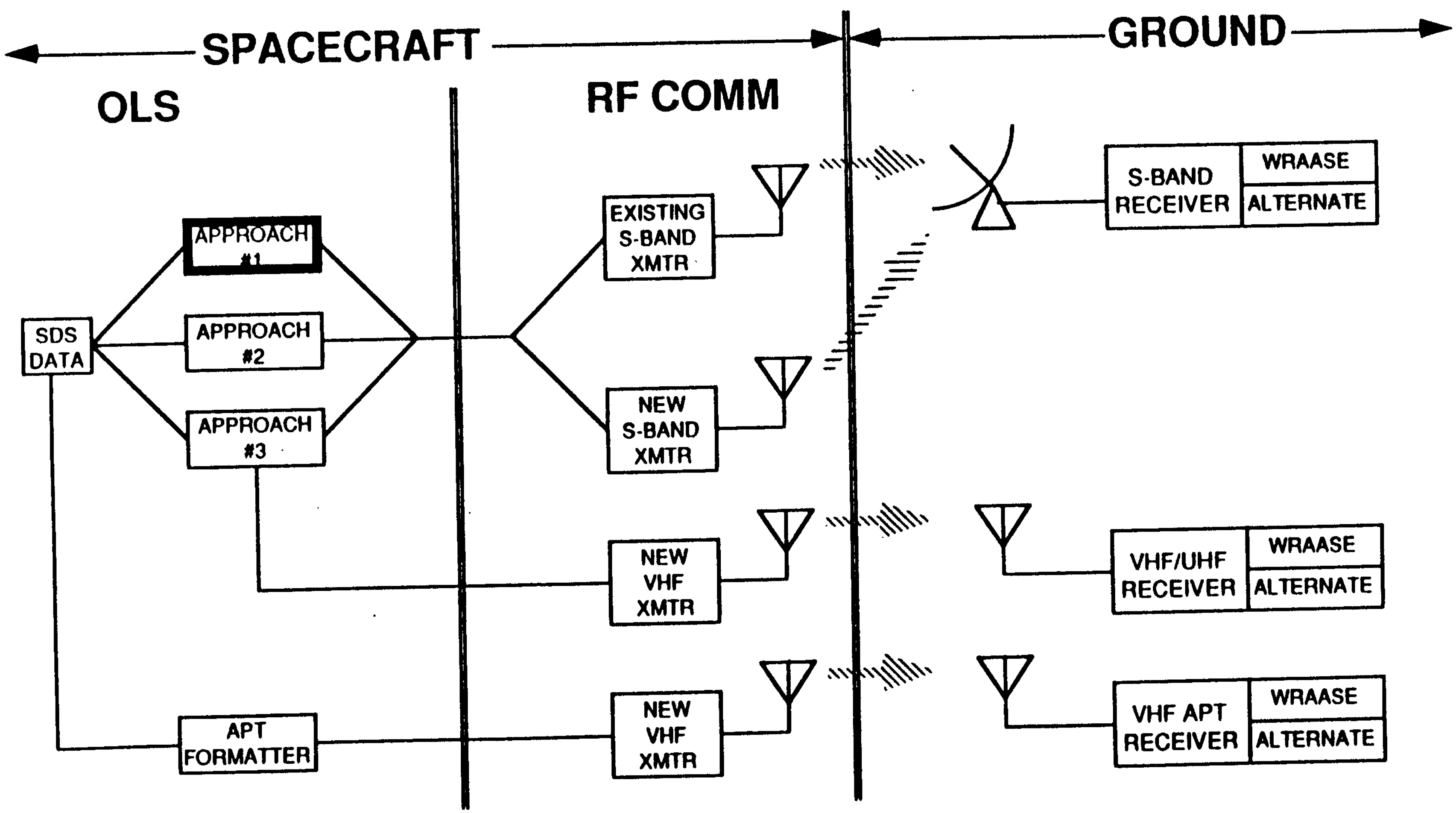
- ALL CLOCKS TO ENCRYPTERS ARE PROVIDED BY THE OSU TO PREVENT THE MODULATION OF CLEAR DATA ONTO ENCRYPTED
- 66.5 KHZ CLOCK IS AVAILABLE ON SAME TEST CONNECTOR AS THE DATA
- USING OLS-16, WEC DETERMINED THAT THE TEST CLOCK MEETS THE MODULATION SPECIFICATIONS FOR AN ENCRYPTER CLOCK
  - MEASUREMENTS INDICATED THAT THERE WAS LESS THAN 5 NSEC OF DATA MODULATION ON THE CLOCK, THE MAXIMUM ALLOWED FOR AN ENCRYPTER CLOCK IS 15 NSEC
- RDS MAY BE ENCRYPTED USING APPROACH #1 WITH ONLY THE ADDITION OF A NEW ENCRYPTER AND CABLES
- THE OLS CURRENTLY HAS CONTROL LINES FOR A FOURTH ENCRYPTER
- OPERATIONAL CONSTRAINT - RDS ENCRYPTED DATA WOULD BE AVAILABLE ONLY FROM FORMATTER-G - NO REDUNDANT PATH

DIGITAL APPROACH #1
OLS IMPACT

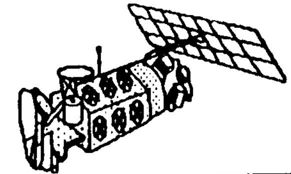


- DIGITAL APPROACH #1 REQUIRES NO CHANGES TO OLS HARDWARE
  - SMOOTH DATA FROM THE G AND H FORMATTERS ARE AVAILABLE ON A TEST CONNECTOR USED FOR GROUND TESTING
  - IN OPERATION, FORMATTER-G SDS DATA FROM THE TEST CONNECTOR WOULD BE ROUTED THROUGH A NEW KG-46 ENCRYPTER TO THE OSU
  - THE OSU WOULD ROUTE THE SMOOTH DATA TO THE APPROPRIATE TRANSMITTER (PDT-2 FOR DEMO)
  - REQUIRES ONLY THE MODIFICATION OF SPACECRAFT CABLE

OLS APPROACH #1

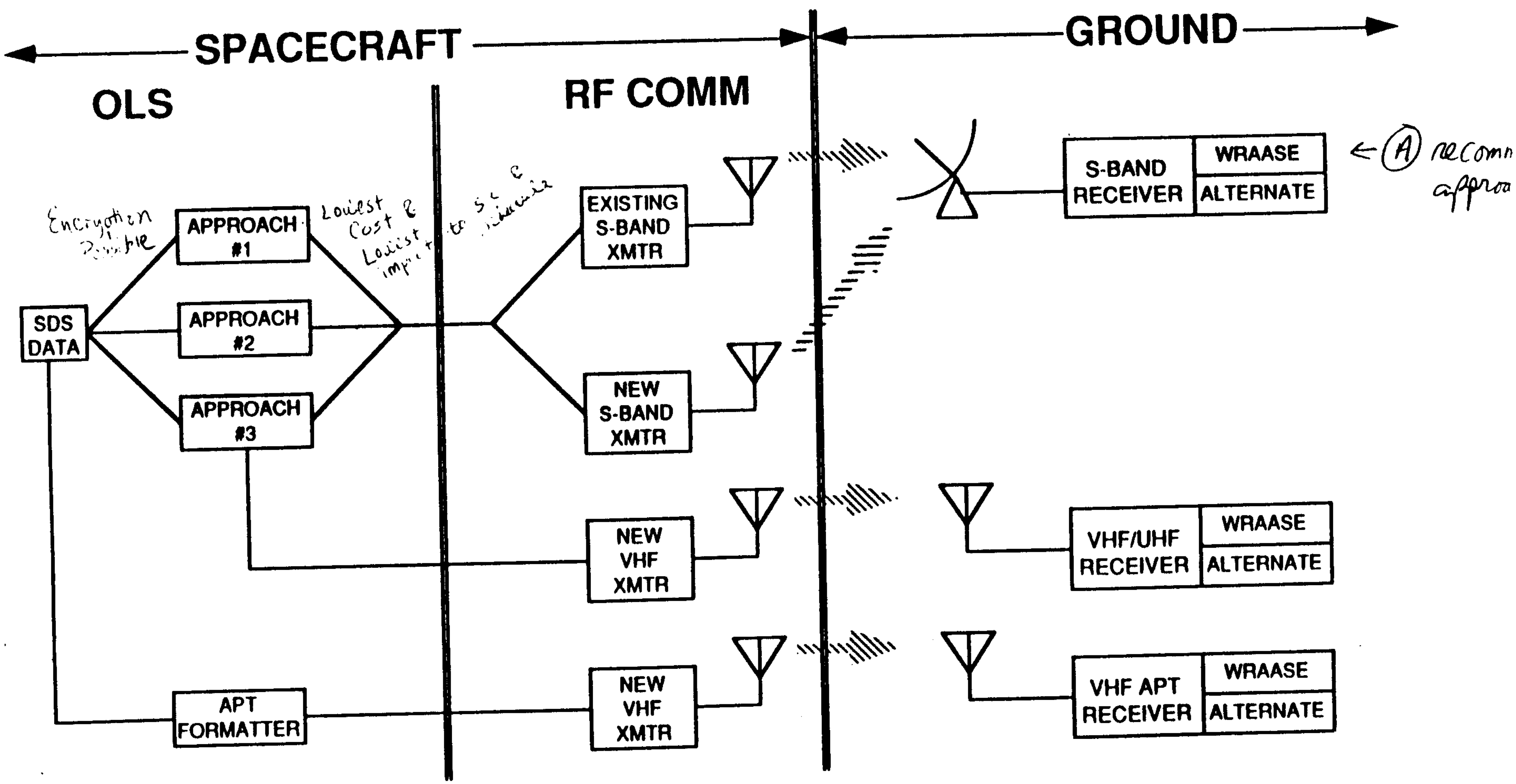


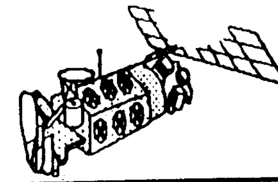
DIGITAL APPROACHES
OLS OVERVIEW



- THERE ARE TWO DEMONSTRATION APPROACHES FOR PROVIDING RDS TO THE S-BAND TRANSMITTERS:
  - APPROACH #1 UTILIZES A TEST CONNECTOR ON THE SPS TO ROUTE RDS TO UNUSED DATA INPUTS ON THE OSU
    - LOWEST COST AND LOWEST IMPACT TO SPACECRAFT AND SCHEDULE
    - ENCRYPTION IS POSSIBLE
  - APPROACH #2 ALSO UTILIZES THE SPS TEST CONNECTOR BUT MODIFIES THE OSU TO PROVIDE A CLEAN ENCRYPTER CLOCK, RATE 1/2 ENCODING AND NRZ-L TO NRZ-M CONVERSION
    - ENCODING SCHEME INCREASES LINK MARGIN
    - NRZ-M CONVERSION REDUCES GROUND COMPLEXITY
  - APPROACH #3 MODIFIES BOTH THE SPS AND OSU, PROVIDING A CLEAN BETWEEN THE SPS, ENCRYPTER AND OSU
    - SAME ENCODING SCHEME AS APPROACH #2
    - PROVIDES REDUNDANT DATA PATH IN SPS

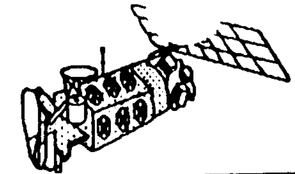
RDS APPROACHES OVERVIEW



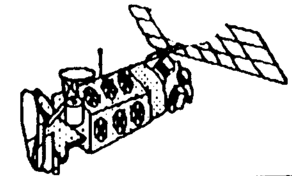


DESIGN APPROACHES

SUMMARY OF BRIEFINGS #1 & #2

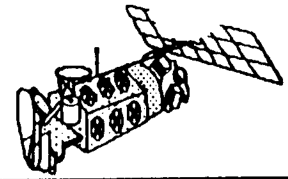


- Finalized the design concepts for all the approaches for the demonstration and the operational systems
- Determined the spacecraft and ground system design modifications necessary to implement all the design approaches
- Presented preliminary design trade-offs and recommendations for optimum implementation of the demonstration and operational systems
- Per USAF direction, requirement for delivery of a functional specification was deleted
- USAF requested a hybrid S-Band - VHF/UHF design approach be considered

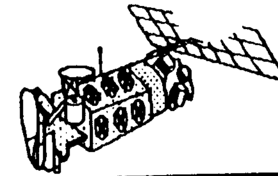


SUMMARY OF
PROGRESS BRIEFINGS #1 AND #2

MEETING OBJECTIVES

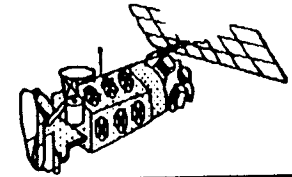


- Present synopsis of design concepts for a demonstration system on 5D-2 satellites, and for an operational system on 5D-3 satellites
- Present transition plan from the demonstration system to the operational system
- Present qualification and acceptance test plans for new and modified satellite units
- Present implementation schedule for each design approach considered
- Provide recommendations for optimum demonstration and operational systems
- Arrive at a comprehensive conclusion of this study



MEETING OBJECTIVES

REQUIREMENTS OF RDS DOWNLINK



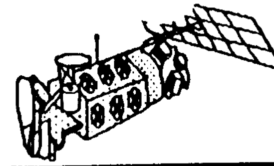
- Use of one of four downlink schemes:
  - S-Band digital
  - VHF/UHF digital
  - Hybrid digital (S-Band and VHF/UHF)
  - VHF analog (APT - equivalent)

- Wraase (or alternative) small tactical receiver compatibility

- Use of existing OLS pre-record RDS data (66.56 Kbps for S11 -S15, 88.746 kbps for S16-S20)

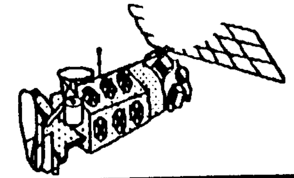
- Encryption for both demonstration and operational systems, with dynamic re-keying highly desirable for the operational system

- Simple scheme to grid (earth-locate) data



REQUIREMENTS OF REALTIME DATA SMOOTH DOWNLINK

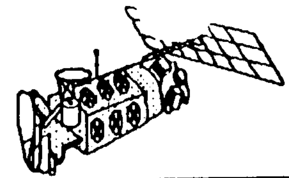
THE NEED FOR REAL TIME DATA SMOOTH (RDS)



WHY RDS ?

TO PROVIDE TACTICAL USERS, DEPLOYED WORLDWIDE, WITH A SURVIVABLE SOURCE OF ENCRYPTED METEO-ROLOGICAL DATA, RECEIVABLE BY SMALL PORTABLE TERMINALS , THAT WILL NOT BE TURNED OFF IN TIME OF CONFL!CT.

TASK OVERVIEW (CONT'D)



- SSD wants short-term (in 2-3 years) demonstration on a 5D-2 satellite; operational system is goal for 5D-3 (S15-S20)

- Products of study will be:

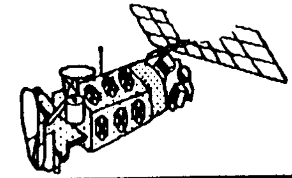
  - Report describing:

    - Recommended configuration for short-term demo system for 5D-2

    - Recommended configuration for an operational system for 5D-3

- Report will include trade-off analyses, required hardware/software modifications (satellite and ground) for selected configuration, and ROM cost and schedule estimates

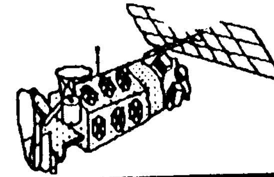
TASK OVERVIEW



- Space Systems Division has issued task assignments to WEC, Harris, and GE to study methods for providing a new tactical data link for DMSP, receivable by small terminals

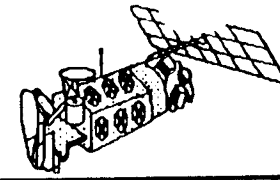
- The three co-contractors are cooperating on a study to investigate and recommend modifications to the current DMSP system to provide a Real Time Data Smooth down-link compatible with the Wraase receiver system or alternative candidate receivers

- Ultimate goal is widespread deployment of DMSP-compatible small tactical receivers (all Army field units, all Navy ships, and all Air Force bases)



REALTIME DATA SMOOTH

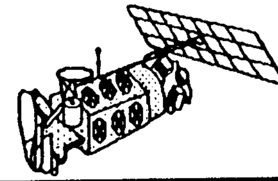
TASK OVERVIEW



OLS REALTIME DATA SMOOTH TRANSMISSION TO SMALL TACTICAL TERMINALS

PROGRESS BRIEFING # 3
27 SEPT 1989

REALTIME DATA SMOOTH STUDY FINAL PROGRESS BRIEFING AGENDA

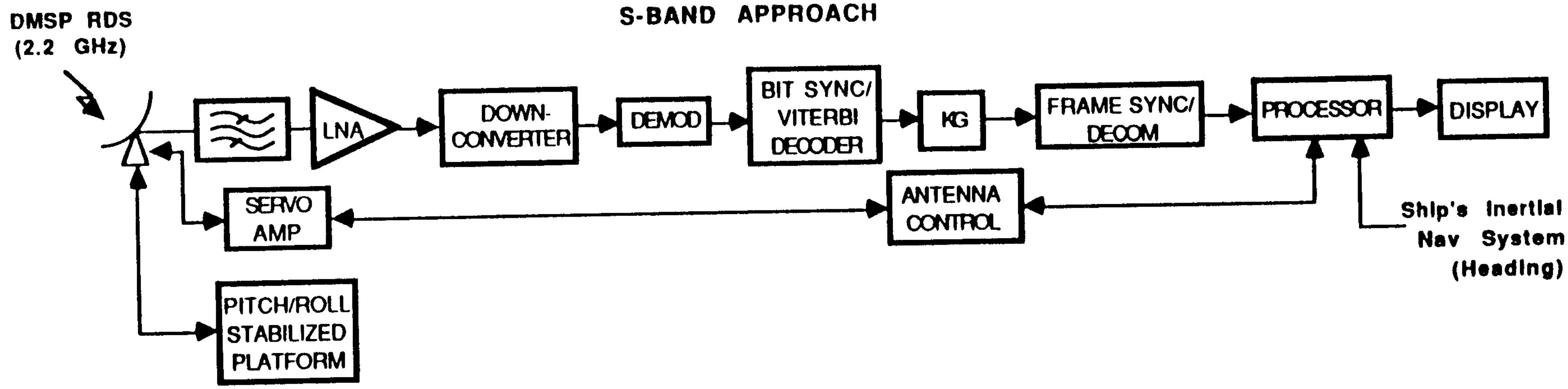


• Realtime Data Smooth Task Overview	GE
• Requirements of Realtime Data Smooth Downlink	GE
• Meeting Objectives	GE
• Summary of Progress Briefings #1 and #2	GE
• Design Approaches	WEC, GE, Harris
• Qualification and Test Plans	WEC, GE
• Tradeoff Matrix	GE
• Summary and Recommendations	Harris
• System Implementation Schedule	WEC, GE, Harris
• Remaining Tasks	GE
• Executive Session	USAF, WEC, GE, Harris

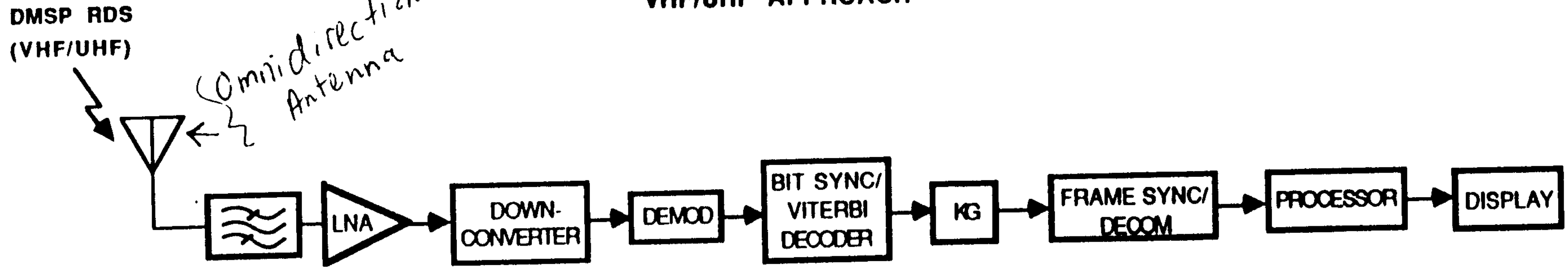
HARRIS
GOVERNMENT INFORMATION
SYSTEMS DIVISION

GENERALIZED BLOCK DIAGRAM FOR SHIPBOARD RDS RECEIVING SYSTEMS

S-BAND APPROACH



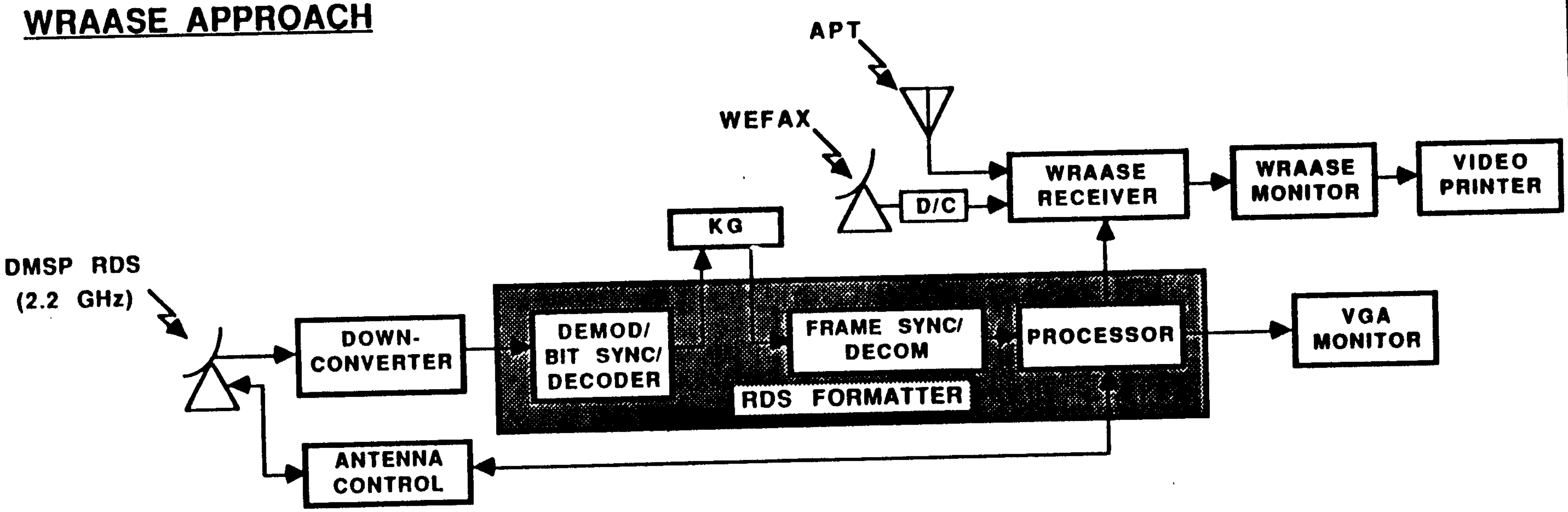
VHF/UHF APPROACH



HARRIS
GOVERNMENT INFORMATION
SYSTEMS DIVISION

S-BAND DIGITAL APPROACHES FOR RDS RECEPTION

WRAASE APPROACH



- LANDBASED VERSIONS SHOWN. SHIPBOARD SYSTEMS ALSO REQUIRE HEADING, PITCH, AND ROLL STABILIZATION
- NO PROVISIONS ARE MADE FOR POINTING THE WEFAX ANTENNA ABOARD SHIP

HARRIS
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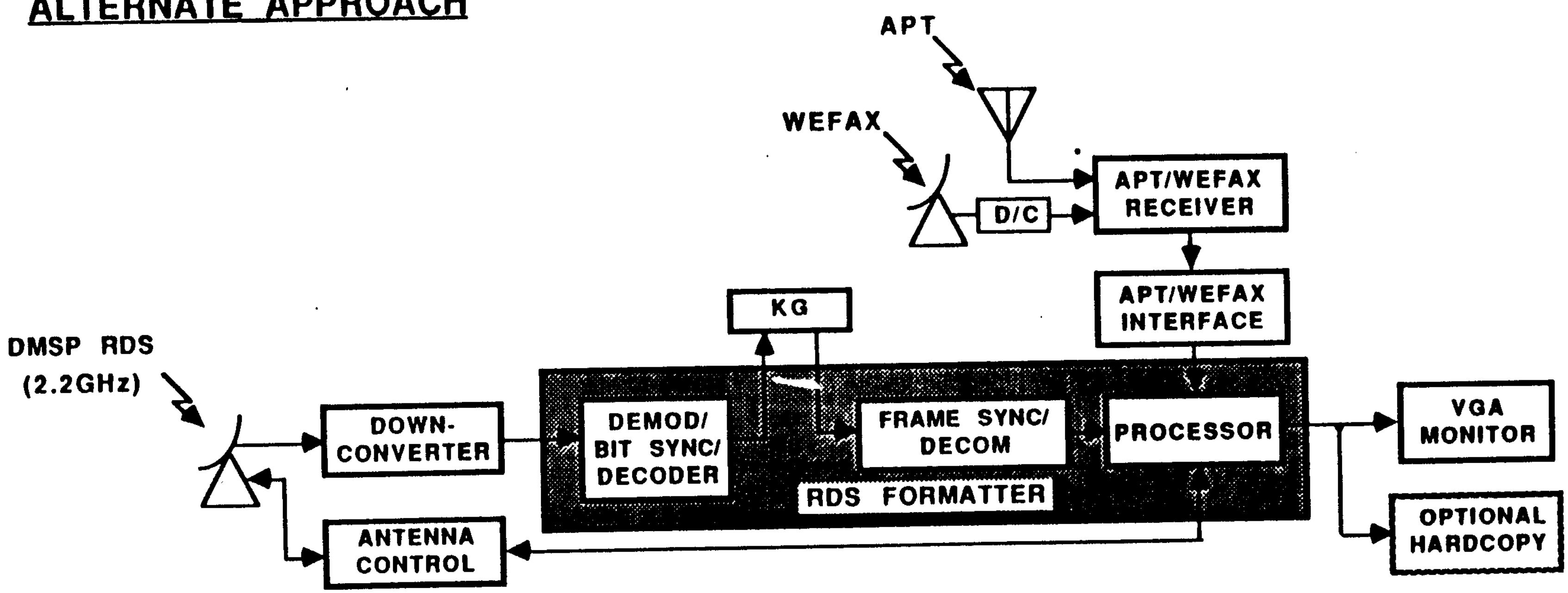
SYSTEMS DIVISION

S-BAND DIGITAL APPROACHES FOR RDS RECEPTION

ALTERNATE APPROACH



- LANDBASED VERSIONS SHOWN. SHIPBOARD SYSTEMS ALSO REQUIRE HEADING, PITCH, AND ROLL STABILIZATION
- NO PROVISIONS ARE MADE FOR POINTING THE WEFAX ANTENNA ABOARD SHIP

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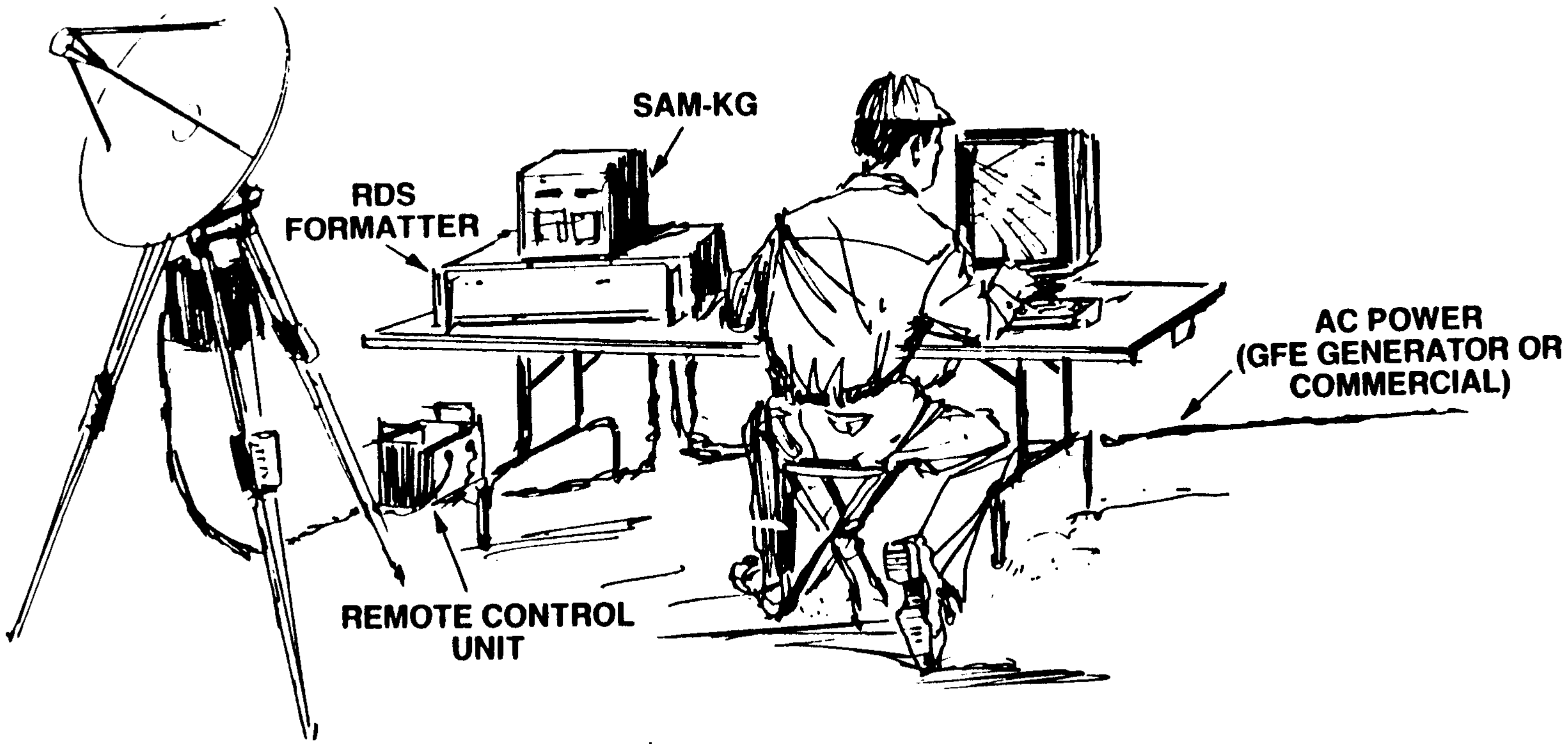
SYSTEMS DIVISION

RDS RECEIVING SYSTEM LAYOUT (ARTIST'S CONCEPT)



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FUNCTIONS OF RDS FORMATTER

- **DEMOD / BIT SYNC / DECODER**
  - -RECEIVES 70 MHZ IF SIGNAL FROM DOWNCONVERTER
  - -TRACKS DOPPLER SHIFT ON RDS SIGNAL
  - -DEMODULATES SIGNAL WITH COSTAS LOOP DEMOD
  - -RECOVERS DATA AND CLOCK WITH BIT SYNCHRONIZER
  - -PERFORMS VITERBI ERROR CORRECTION DECODING
- **FRAME SYNC / DECOM**
  - -DEINTERLEAVES VISUAL AND THERMAL DATA
  - -DETECTS FRAME SYNC, LINE SYNC, AND LINE SUB-SYNC PATTERNS
  - -CONVERTS DATA TO PARALLEL WORDS
  - -PERFORMS EARTH CURVATURE CORRECTION
  - -BUFFERS DATA FOR DMA INTO MEMORY
- **PROCESSOR**
  - -MANAGES DATA STORAGE, RETRIEVAL, AND DISPLAY
  - -CONTROLS DEMOD/BIT SYNC AND FRAME SYNC/DECOM
  - -PERFORMS GRIDDING CALCULATIONS
  - -ACCEPTS OPERATOR INPUT OF NORAD TWO-CARD EPHEMERIS DATA SETS
  - -CALCULATES ANTENNA POINTING ANGLES
  - -CONTROLS ANTENNA POSITION DURING PASS

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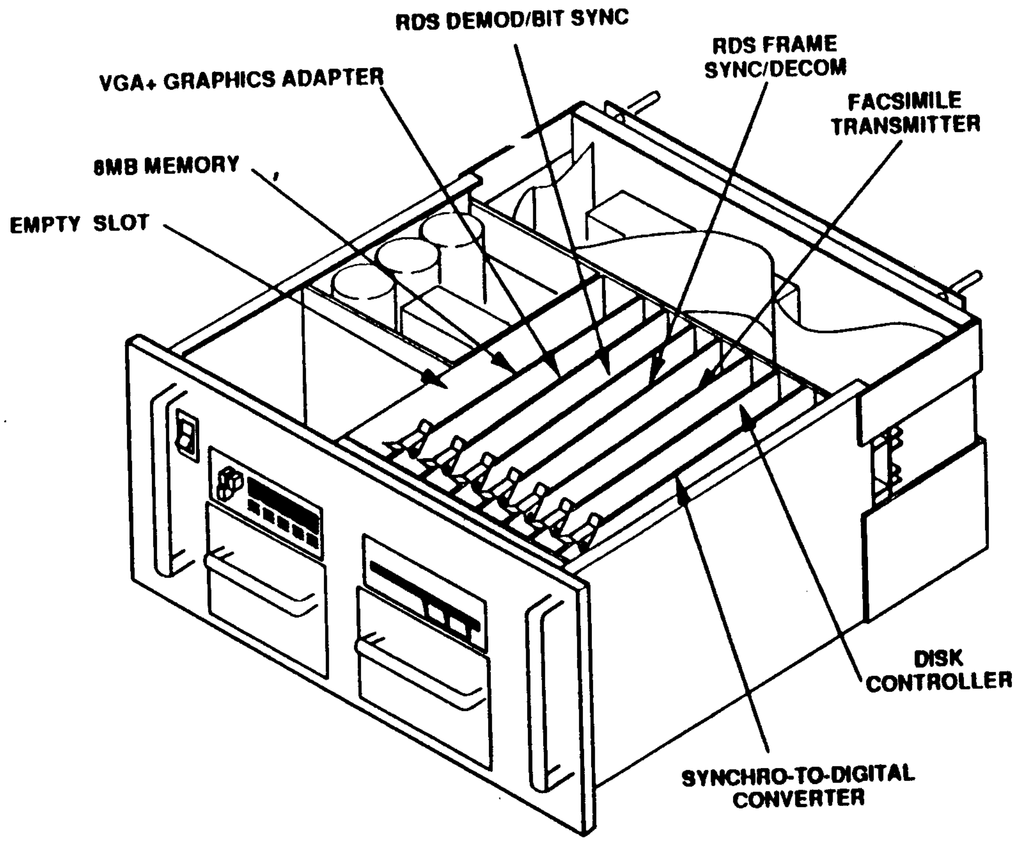
SYSTEMS DIVISION

RDS FORMATTER LAYOUT (ARTIST'S CONCEPT)



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RDS FORMATTER CONFIGURATION FOR S-BAND AND VHF/UHF DIGITAL APPROACHES

	WRAASE APPROACH	ALTERNATE APPROACH
PC/AT-COMPATIBLE PROCESSOR WITH FLOATING POINT COPROCESSOR AND 40MB HARD DISK	X	X
8MB EMS MEMORY	X	X
VGA+ GRAPHICS ADAPTER	X	X
RDS DEMOD / BIT SYNC / DECODER (NOTE 1)	X	X
RDS FRAME SYNC/DECOM	X	X
FACSIMILE TRANSMITTER	X	
APT/WEFAX ACQUISITION CARD		X
SYNCHRO-TO-DIGITAL CONVERTER (NOTE 2)	X	X

NOTE 1: VITERBI ERROR CORRECTION DECODING IS BYPASSED DURING S-BAND DEMO PHASE

NOTE 2: SYNCHRO-TO-DIGITAL CONVERSION CARD REQUIRED ONLY IN SHIPBOARD S-BAND SYSTEMS

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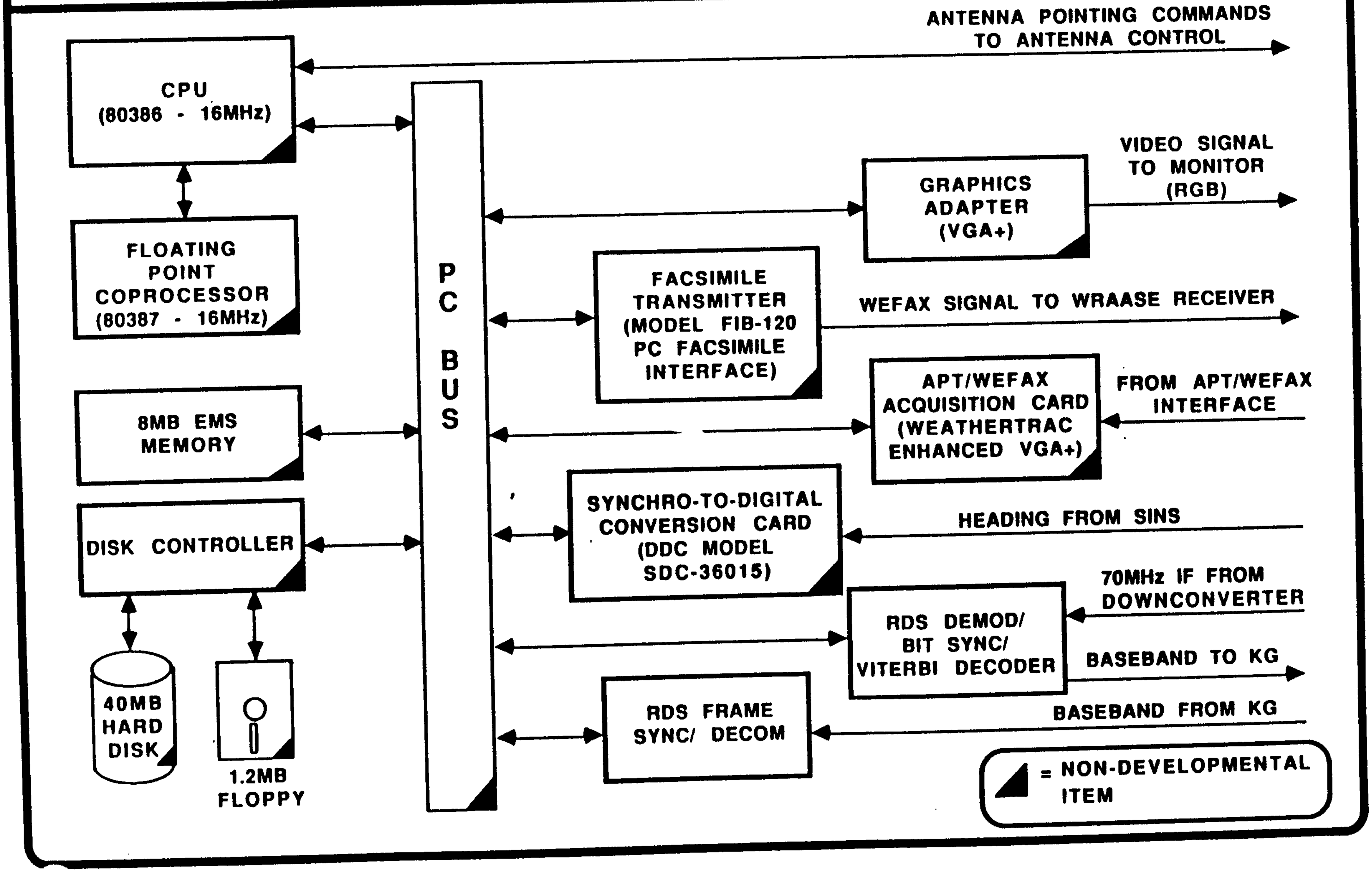
SYSTEMS DIVISION

RDS FORMATTER BLOCK DIAGRAM



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ANTENNA POINTING APPROACH

- DUE TO THE WIDE BEAMWIDTH OF THE ANTENNA, ONLY PROGRAM TRACKING IS REQUIRED.

- AS RECOMMENDED BY SPACE COMMAND, THE SYSTEM WILL UTILIZE THE NORAD SGP4 MODEL TO DETERMINE SATELLITE POSITION.

  -EPHEMERIS DATA SUPPLIED BY NORAD TWO-CARD ELEMENT SETS.

  -POSITION DATA TRANSMITTED BY THE SATELLITE WILL BE USED TO PSEUDO-AUTOTRACK FOR BETTER POINTING ACCURACY BETWEEN EPHEMERIS DATA UPDATES.

- POINTING ALGORITHM REQUIRES ACCURATE CURRENT TIME. THIS IS PROVIDED BY THE PROCESSOR'S INTERNAL CLOCK WHICH WILL BE AUTOMATICALLY UPDATED FROM THE SATELLITE'S CLOCK DURING EVERY TRACKED SATELLITE PASS.

- ON SHIPBOARD APPLICATIONS, THE PROCESSOR WILL OBTAIN SHIP'S HEADING FROM THE SHIP'S INERTIAL NAVIGATION SYSTEM (SINS), IF AVAILABLE, OR FROM AN INDEPENDENT GYROCOMPASS IF SINS IS NOT AVAILABLE.

LATITUDE/LONGITUDE GRID OVERLAYS AND EARTH-LOCATION

- THE SYSTEM WILL AUTOMATICALLY PRODUCE LATITUDE / LONGITUDE GRID OVERLAYS.
- IT WILL ALSO BE POSSIBLE TO EARTH-LOCATE OBJECTS OF INTEREST IN THE IMAGE
- THE SATELLITE POSITION WILL BE DETERMINED USING THE LOCATION DATA CONTAINED IN THE RDS DATA STREAM.
- SINCE LOCATION DATA IS PROVIDED IN REAL-TIME BY THE SATELLITE, EXTREMELY ACCURATE CURRENT TIME DATA IS NOT REQUIRED.

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SYSTEMS DIVISION

S-BAND DIGITAL APPROACH POWER AND WEIGHT ESTIMATES

ITEM	WEIGHT (POUNDS)	AC POWER (WATTS)
RDS FORMATTER (TEMPEST)	45	300
MONITOR (TEMPEST)	45	105
ANTENNA AND POSITIONER	40	----
REMOTE CONTROL UNIT	26	575 (PEAK)
CRYPTO (ASSUME SAM-KG)	25	40
TOTALS (EXCLUDING APT/WEFAX):	181	1020 (PEAK)

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SYSTEMS DIVISION

S-BAND DIGITAL APPROACH RECEIVING TERMINAL PACKAGING

THE S-BAND DIGITAL RDS RECEIVING TERMINAL WILL BE SHIPPED ON ONE PALLET:

- THREE SHIPPING CONTAINERS
  - RDS FORMATTER
  - MONITOR AND KEYBOARD
  - ANTENNA POSITIONER AND REMOTE CONTROL
- THREE CABLE REELS
  - COAX
  - AC POWER
  - ANTENNA CONTROL
- ANTENNA TRIPOD
- ANTENNA REFLECTOR
- CRYPTO HANDLED SEPARATELY BY CRYPTO CUSTODIAN

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GOVERNMENT INFORMATION
SYSTEMS DIVISION

S-BAND DIGITAL APPROACH RECEIVING TERMINAL SETUP TIME

ACTION	TIME (MINUTES)
UNPACK CONTAINERS	10
DEPLOY AND CONNECT EQUIPMENT	10
ASSEMBLE AND ORIENT ANTENNA	10
APPLY POWER AND CHECK OUT SYSTEM	10
TOTAL SETUP TIME	40

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SYSTEMS DIVISION

PROS AND CONS OF S-BAND DIGITAL APPROACH

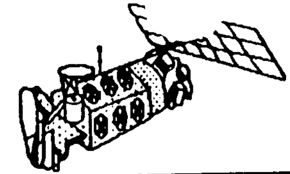
ADVANTAGES:

- MINIMAL SATELLITE MODIFICATIONS
- FASTEST ROUTE TO DEMONSTRATION SYSTEM
- MISSION SENSOR DATA TRANSMITTED
- ENCRYPTION IS POSSIBLE
- FULL RDS RESOLUTION
- FREQUENCY ALLOCATION NOT DIFFICULT
- LESS SUSCEPTIBLE TO RFI AND JAMMING THAN OTHER APPROACHES (S-BAND USES DIRECTIONAL RECEIVING ANTENNA)

DISADVANTAGES:

- REQUIRES STEERABLE ANTENNA IN RECEIVING SYSTEM
  - -RECEIVING SYSTEM MORE COMPLEX THAN OTHER APPROACHES
  - -SHIPBOARD RECEPTION REQUIRES PITCH, ROLL, AND HEADING STABILIZATION

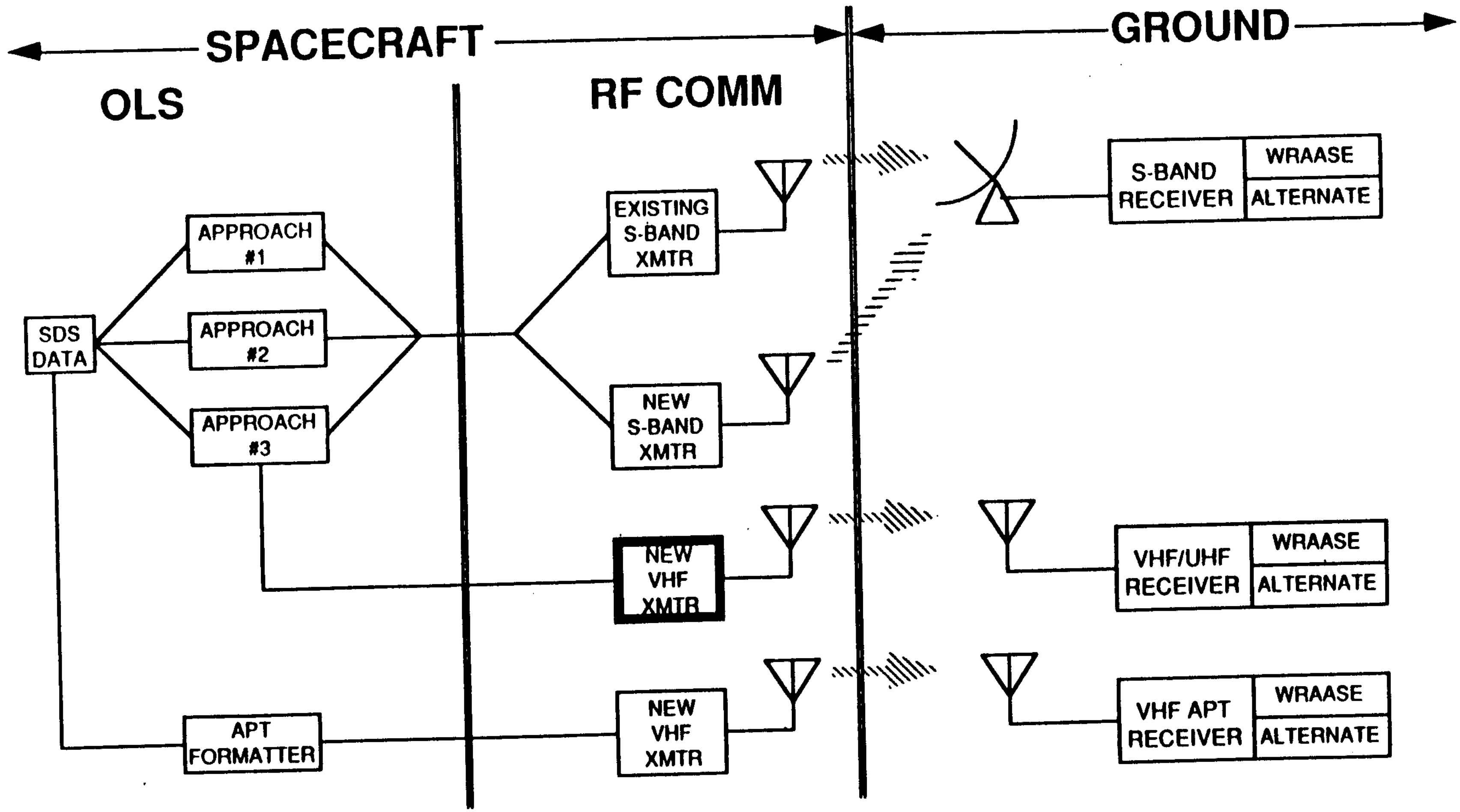
SPACECRAFT RF COMMUNICATIONS



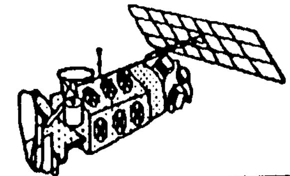
VHF/UHF

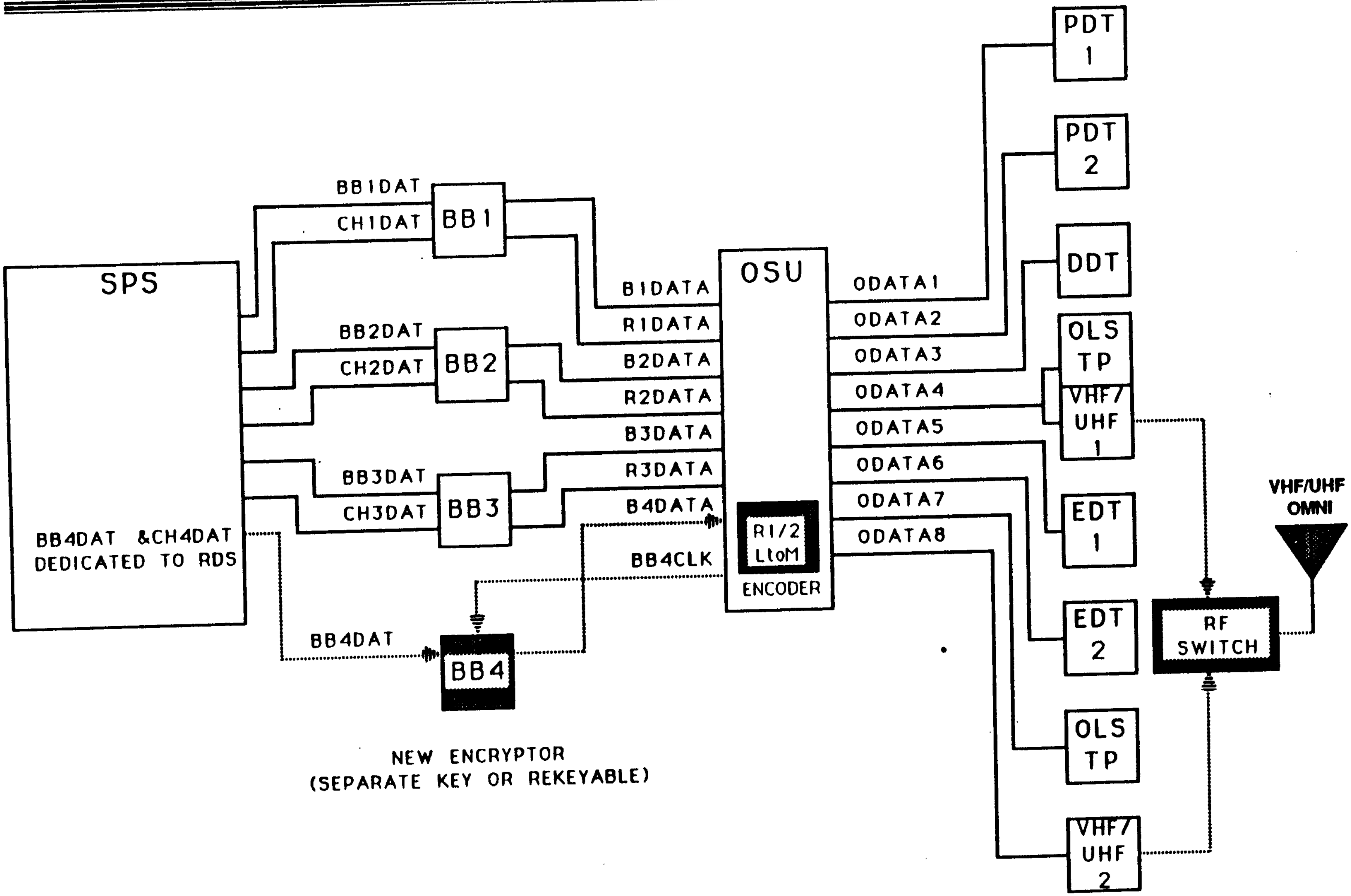
- Route RDS data the same way as for the S-band link to dedicated VHF/UHF transmitters and modified TIROS-design antenna
- Design modifications to spacecraft RF communications equipments same as for S-Band link except for specific transmitter /antenna design
- Dedicated transmitters, RF switch, and antenna will be added
  - Tradeoff study performed between in-house designed transmitter and vendor designed transmitter
  - RF switch and antenna based on TIROS design
- Lower frequency allows link closure with omnidirectional antenna on the ground

RF COMMUNICATIONS VHF/UHF



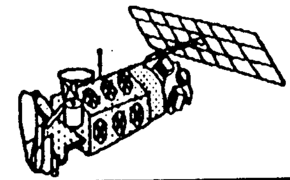
SPACECRAFT RF COMMUNICATION VHF/UHF

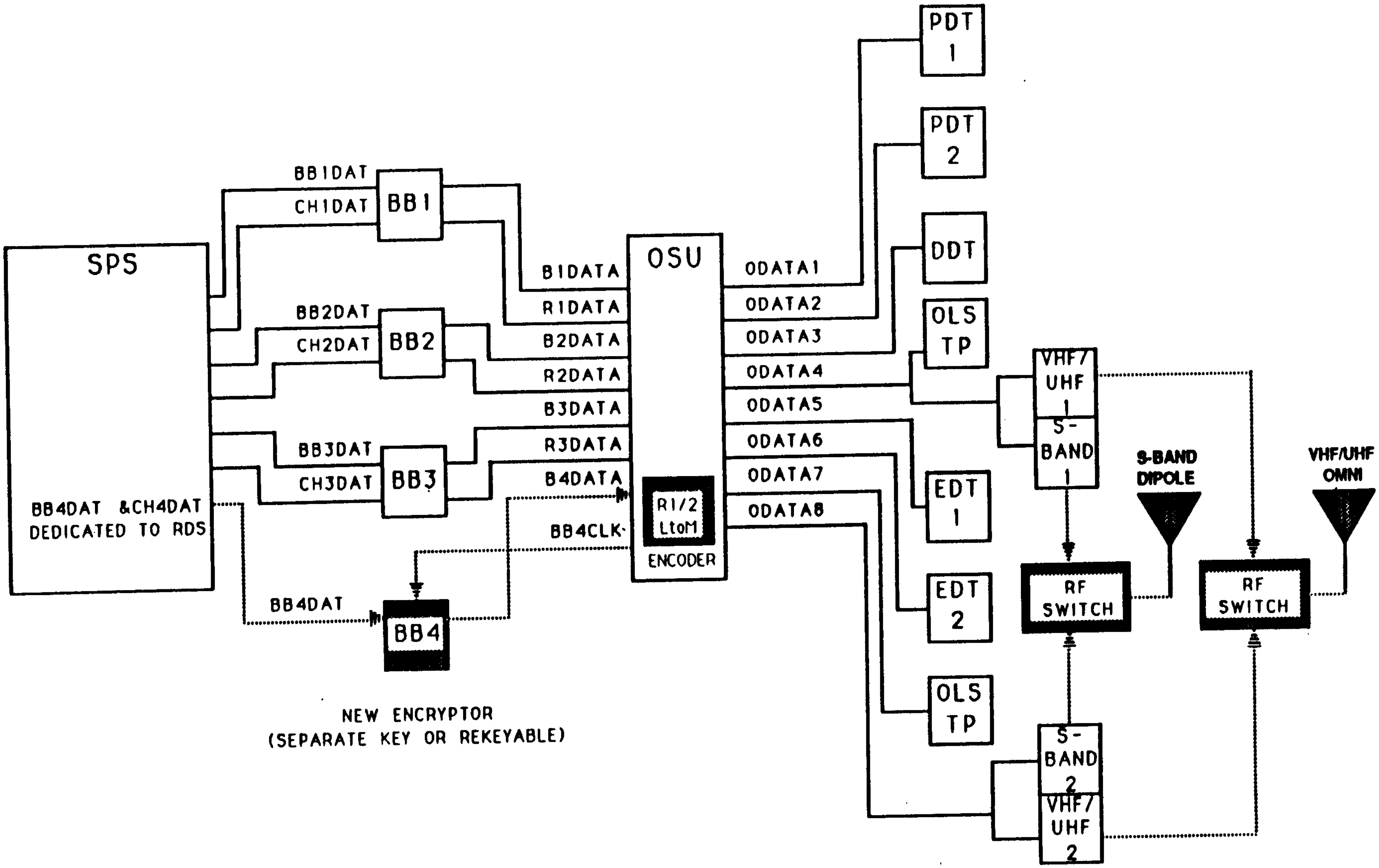




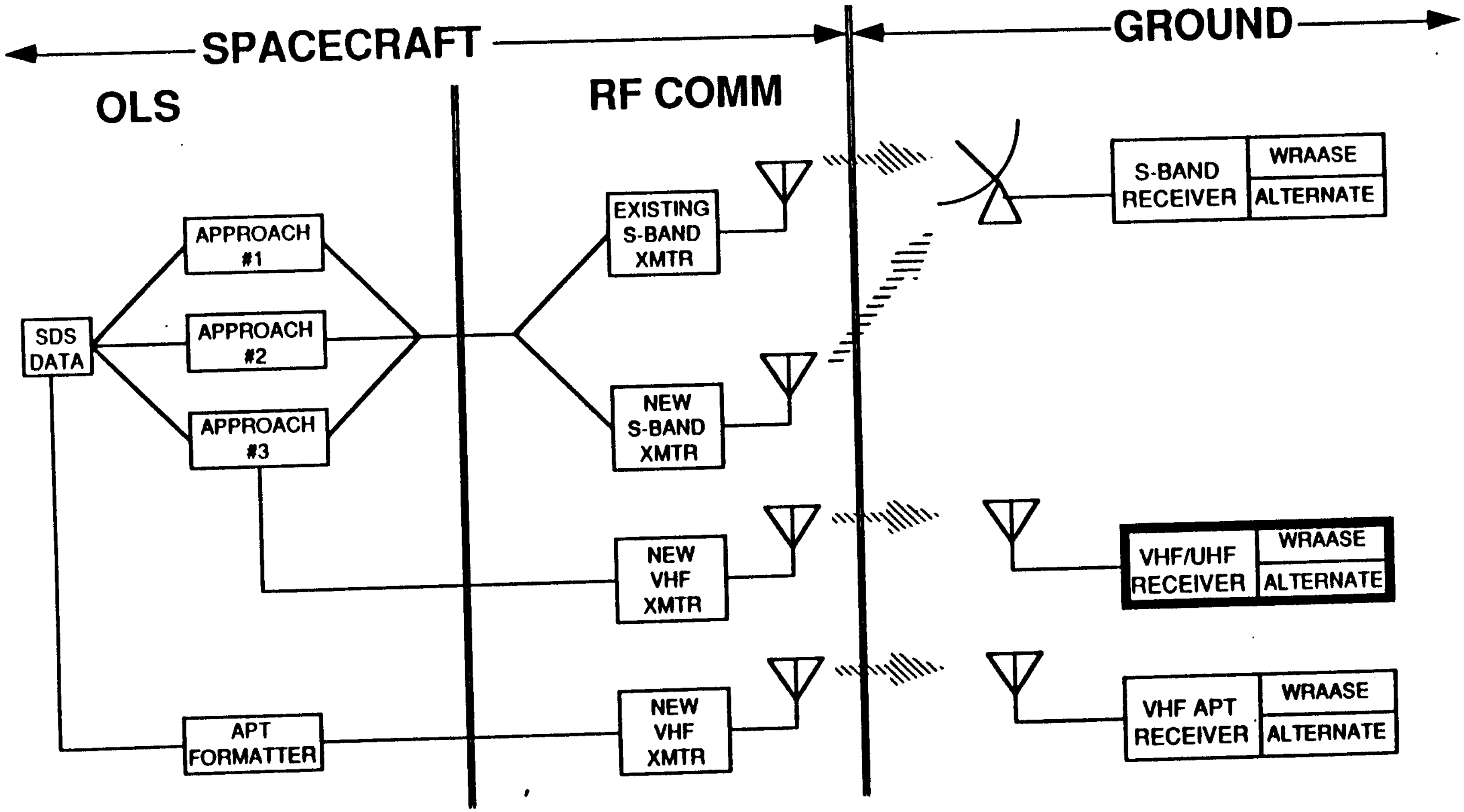
NEW ENCRYPTOR
(SEPARATE KEY OR REKEYABLE)

SPACECRAFT RF COMUNICATION
DUAL S-BAND VHF/UHF





GROUND - VHF/UHF



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SYSTEMS DIVISION

VHF/UHF DIGITAL APPROACH EVALUATION CRITERIA

- SATELLITE COMPLEXITY
- RECEIVING SYSTEM COMPLEXITY
- AVAILABILITY OF MISSION SENSOR DATA
- FEASIBILITY OF ENCRYPTION
- RESOLUTION OF IMAGERY
- DIFFICULTY OF OBTAINING FREQUENCY ALLOCATION
- SUSCEPTIBILITY TO RADIO FREQUENCY INTERFERENCE (RFI)
- SUSCEPTIBILITY TO JAMMING

NOTE: THE SAME EVALUATION CRITERIA ARE USED FOR ALL APPROACHES

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SYSTEMS DIVISION

REALTIME DATA SMOOTH (RDS) LINK BUDGET SUMMARY

CASE	REQUIRED RECEIVING ANTENNA GAIN	RECEIVING ANTENNA SIZE
1. 2237.5 MHz, SPACECRAFT OMNI ANT, 1.024 MHz SUBCARRIER	25.1 dB	4.0 FEET
2. 2237.5 MHz, SPACECRAFT DIRECTIONAL ANT, 1.024 MHz SUBCARRIER	18.3 dB	1.8 FEET
3. 2267.5 MHz, SPACECRAFT DIRECTIONAL ANT, DIRECT MODULATION	15.4 dB	1.3 FEET
4. 2267.5 MHz, SPACECRAFT DIRECTIONAL ANT, DIRECT MODULATION, CONVOLUTIONAL CODING	10.4 dB	<1 FOOT
5. 137.5 MHz, TIROS ANTENNA, DIRECT MODULATION, CONVOLUTIONAL CODING	-3.7 dB	OMNI
6. 225 MHz, TIROS-LIKE ANTENNA, DIRECT MODULATION, CONVOLUTIONAL CODING	-3.4 dB	OMNI

NOTE THAT THE VHF/UHF APPROACHES ONLY REQUIRE OMNIDIRECTIONAL RECEIVING ANTENNAS

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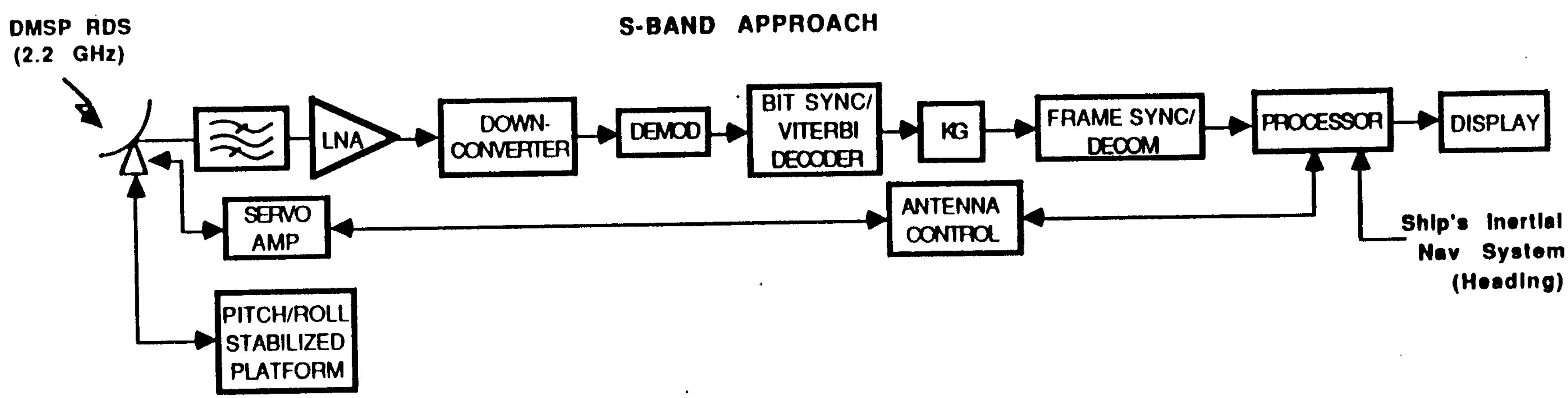
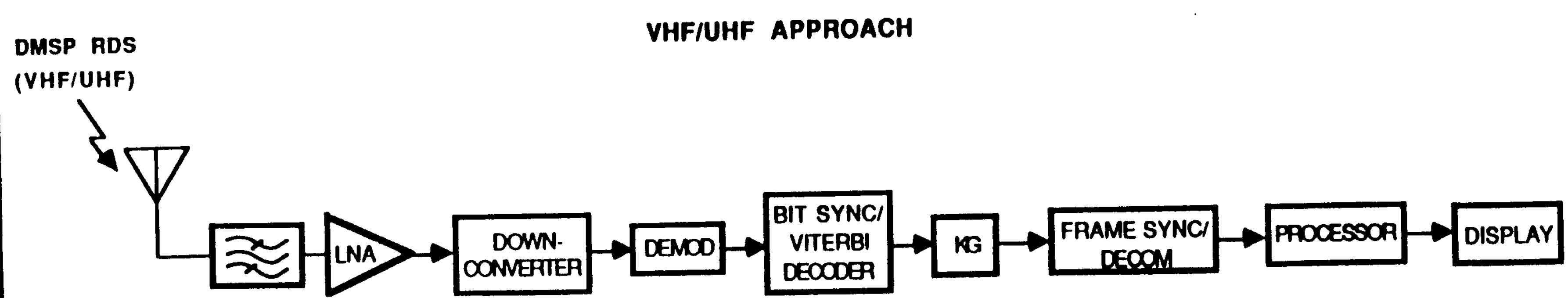
SYSTEMS DIVISION

GENERALIZED BLOCK DIAGRAM FOR SHIPBOARD RDS RECEIVING SYSTEMS





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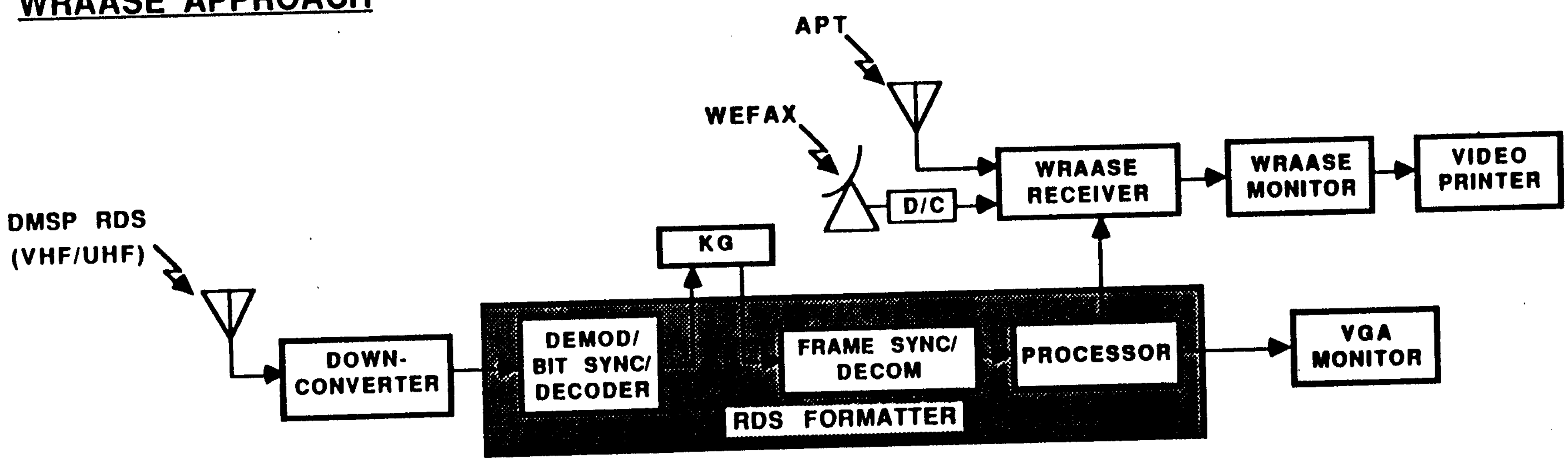
VHF/UHF DIGITAL APPROACHES FOR RDS RECEPTION

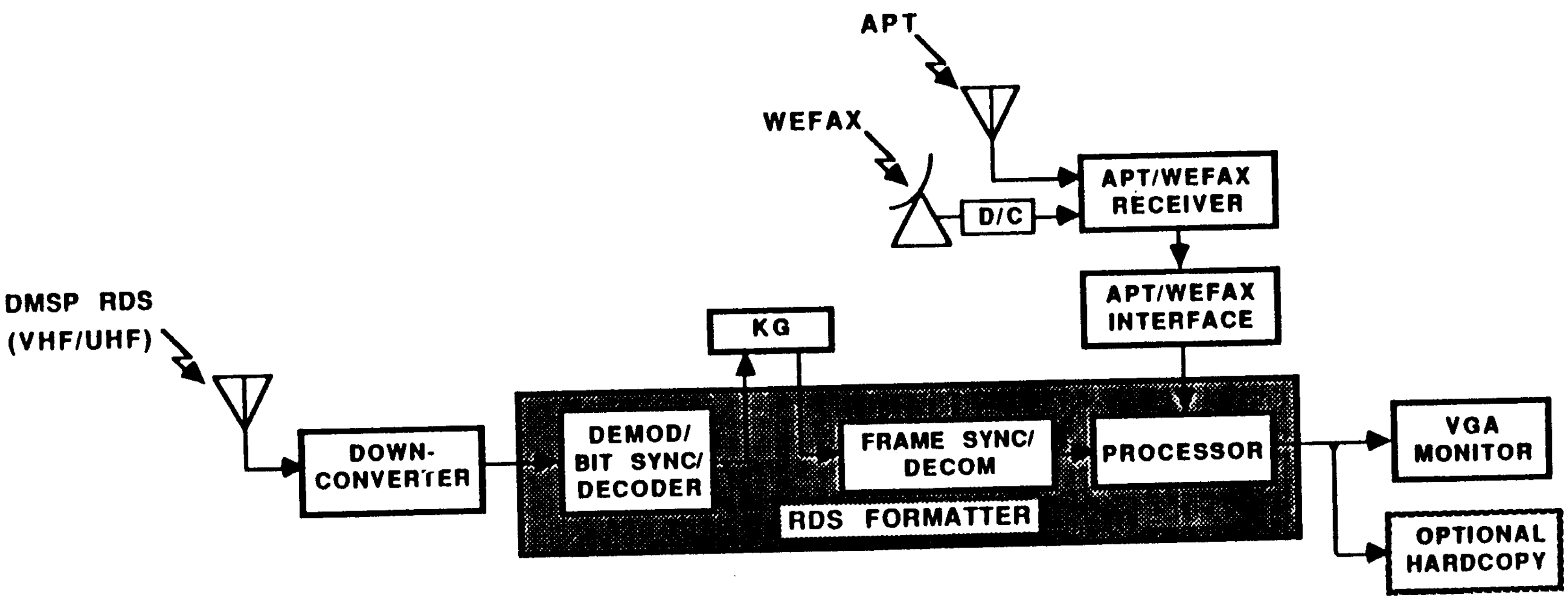
WRAASE APPROACH



•NO PROVISIONS ARE MADE FOR POINTING THE WEFAX ANTENNA ABOARD SHIP

VHF/UHF DIGITAL APPROACHES FOR RDS RECEPTION

ALTERNATE APPROACH



- NO PROVISIONS ARE MADE FOR POINTING THE WEFAX ANTENNA ABOARD SHIP

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SYSTEMS DIVISION

CHANGES TO RDS FORMATTER IN VHF/UHF APPROACHES

- VHF/ UHF APPROACHES USE THE SAME BASIC RDS FORMATTER AS THE S-BAND APPROACHES, WITH SOME FUNCTIONS DELETED:

  -ANTENNA POINTING FUNCTION IS NOT REQUIRED

  -SHIP'S INERTIAL NAV SYSTEM (SINS) INTERFACE IS NOT REQUIRED

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SYSTEMS DIVISION

VHF/UHF DIGITAL APPROACH POWER AND WEIGHT ESTIMATES

ITEM	WEIGHT (POUNDS)	AC POWER (WATTS)
RDS FORMATTER (TEMPEST)	45	300
MONITOR (TEMPEST)	45	105
ANTENNA	10	----
CRYPTO (ASSUME SAM-KG)	25	40
TOTALS (EXCLUDING APT/WEFAX):	125	445

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SYSTEMS DIVISION

VHF/UHF DIGITAL APPROACH RECEIVING TERMINAL PACKAGING

THE VHF/UHF DIGITAL RDS RECEIVING TERMINAL WILL BE SHIPPED ON ONE PALLET:

- TWO SHIPPING CONTAINERS
  - RDS FORMATTER
  - MONITOR AND KEYBOARD
- TWO CABLE REELS
  - COAX
  - AC POWER
- ANTENNA TRIPOD
- ANTENNA
- CRYPTO HANDLED SEPARATELY BY CRYPTO CUSTODIAN

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VHF/UHF DIGITAL APPROACH RECEIVING TERMINAL SETUP TIME

ACTION	TIME (MINUTES)
UNPACK CONTAINERS	10
DEPLOY AND CONNECT EQUIPMENT	10
APPLY POWER AND CHECK OUT SYSTEM	10
TOTAL SETUP TIME	30

(vs 40 for S-Band Digital approach)

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PROS AND CONS OF VHF/UHF DIGITAL APPROACH

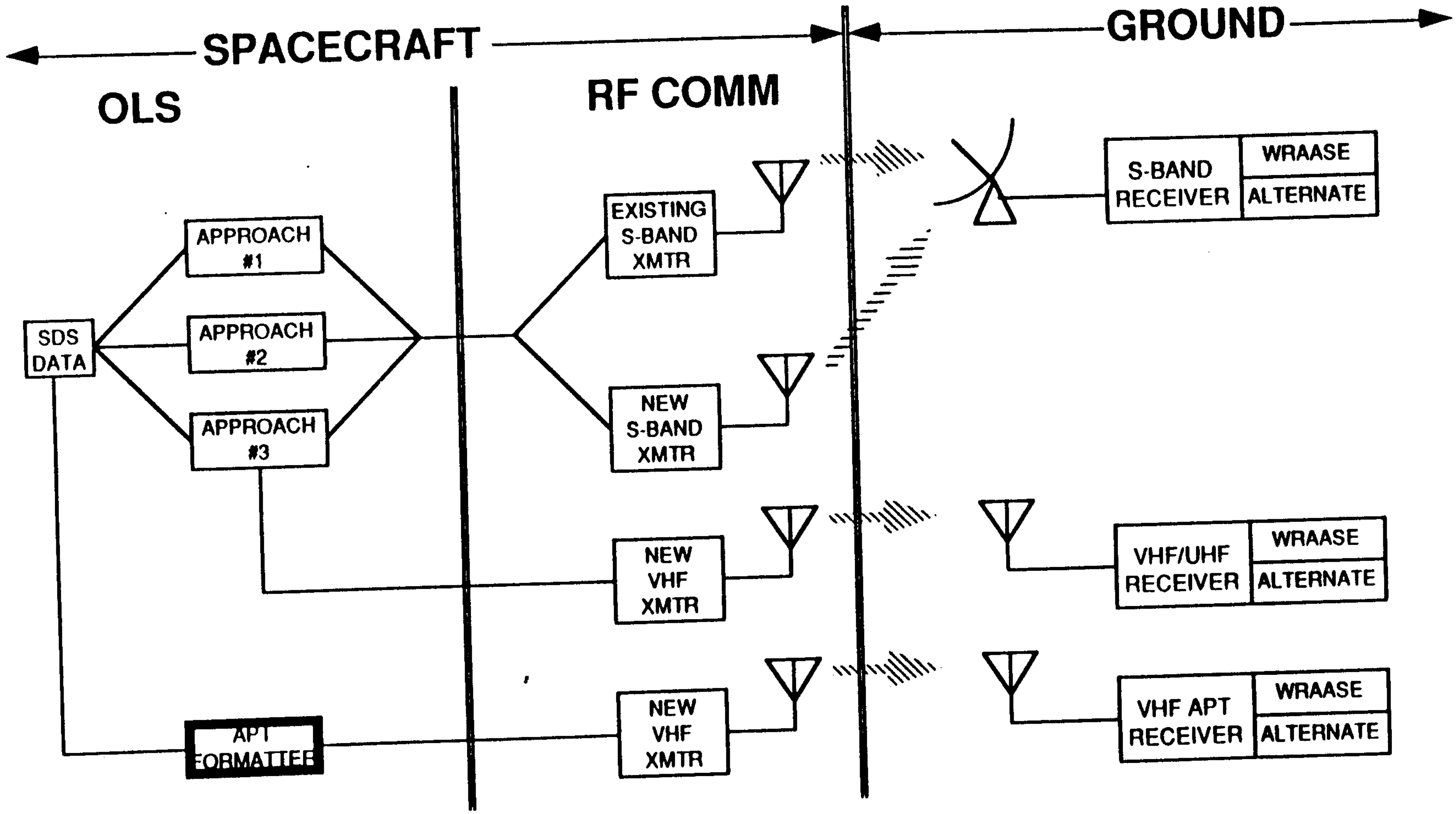
ADVANTAGES:

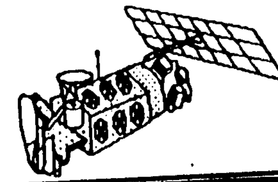
- DOES NOT REQUIRE STEERABLE ANTENNA IN RECEIVING SYSTEM
  - -REDUCES RECEIVING SYSTEM COMPLEXITY SIGNIFICANTLY
  - -GREATLY SIMPLIFIES SHIPBOARD INSTALLATION
- MISSION SENSOR DATA TRANSMITTED
- ENCRYPTION IS POSSIBLE
- FULL RDS RESOLUTION

DISADVANTAGES:

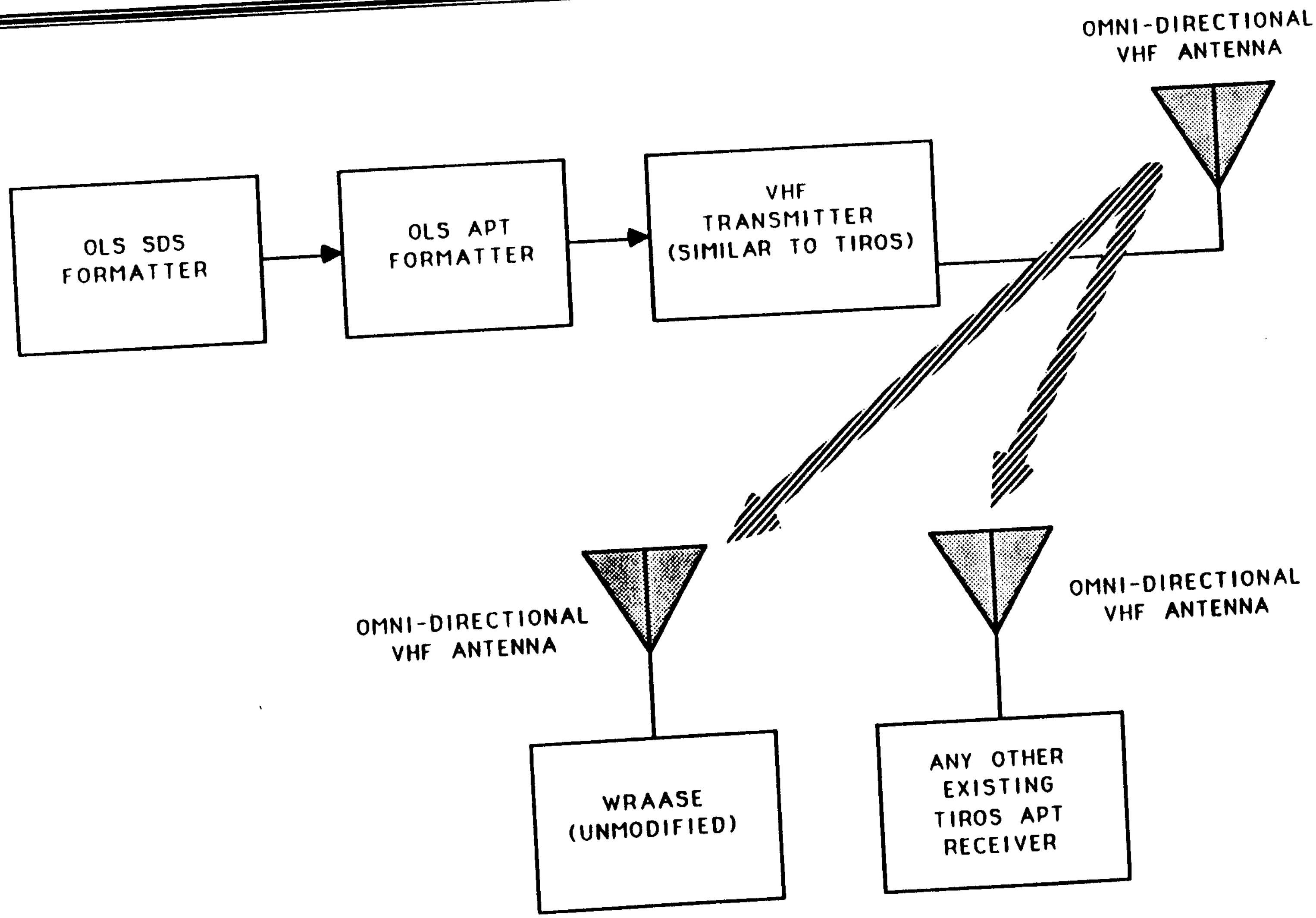
- MORE SATELLITE MODIFICATIONS THAN S-BAND DEMO APPROACH
  - -NOT A CANDIDATE FOR A SHORT-TERM DEMO SYSTEM
- FREQUENCY ALLOCATION MAY BE DIFFICULT
- OMNI ANTENNA IS MORE SUSCEPTIBLE TO RFI AND JAMMING THAN DIRECTIONAL ANTENNA USED IN S-BAND APPROACH

OLS APT

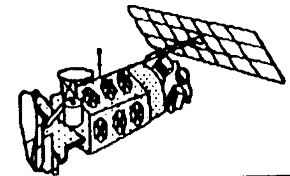

SPACECRAFT
GROUND
OLS
RF COMM
SDS DATA
APPROACH #1
APPROACH #2
APPROACH #3
APT FORMATTER
EXISTING S-BAND XMTR
NEW S-BAND XMTR
NEW VHF XMTR
NEW VHF XMTR
S-BAND RECEIVER
WRAASE
ALTERNATE
VHF/UHF RECEIVER
WRAASE
ALTERNATE
VHF APT RECEIVER
WRAASE
ALTERNATE



APT BLOCK DIAGRAM

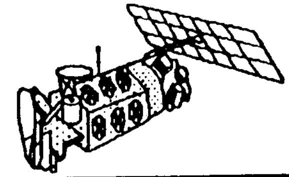


APT OVERVIEW



- THE SENSOR APPROACH FOR APT IS ESSENTIALLY UNCHANGED FROM THAT PRESENTED AT THE LAST TWO BRIEFINGS
- SPACECRAFT IMPACT
  - MODIFY OLS TO PROVIDE APT VERSION OF SMOOTH DATA STREAM
  - ADD UHF OR VHF MODULATOR/TRANSMITTER/ANTENNA ASSEMBLY TO SPACECRAFT
  - MODIFY SPACECRAFT HARNESS
- GROUND IMPACT
  - ESSENTIALLY NONE
  - WRAASE MAY BE USED UNMODIFIED, ONLY REQUIRES ADDITION OF A NEW CRYSTAL

APT OVERVIEW



- THE SENSOR APPROACH FOR APT IS ESSENTIALLY UNCHANGED FROM THAT PRESENTED AT THE LAST TWO BRIEFINGS
- SPACECRAFT IMPACT
  - MODIFY OLS TO PROVIDE APT VERSION OF SMOOTH DATA STREAM
  - ADD UHF OR VHF MODULATOR/TRANSMITTER/ANTENNA ASSEMBLY TO SPACECRAFT
  - MODIFY SPACECRAFT HARNESS
- GROUND IMPACT
  - ESSENTIALLY NONE
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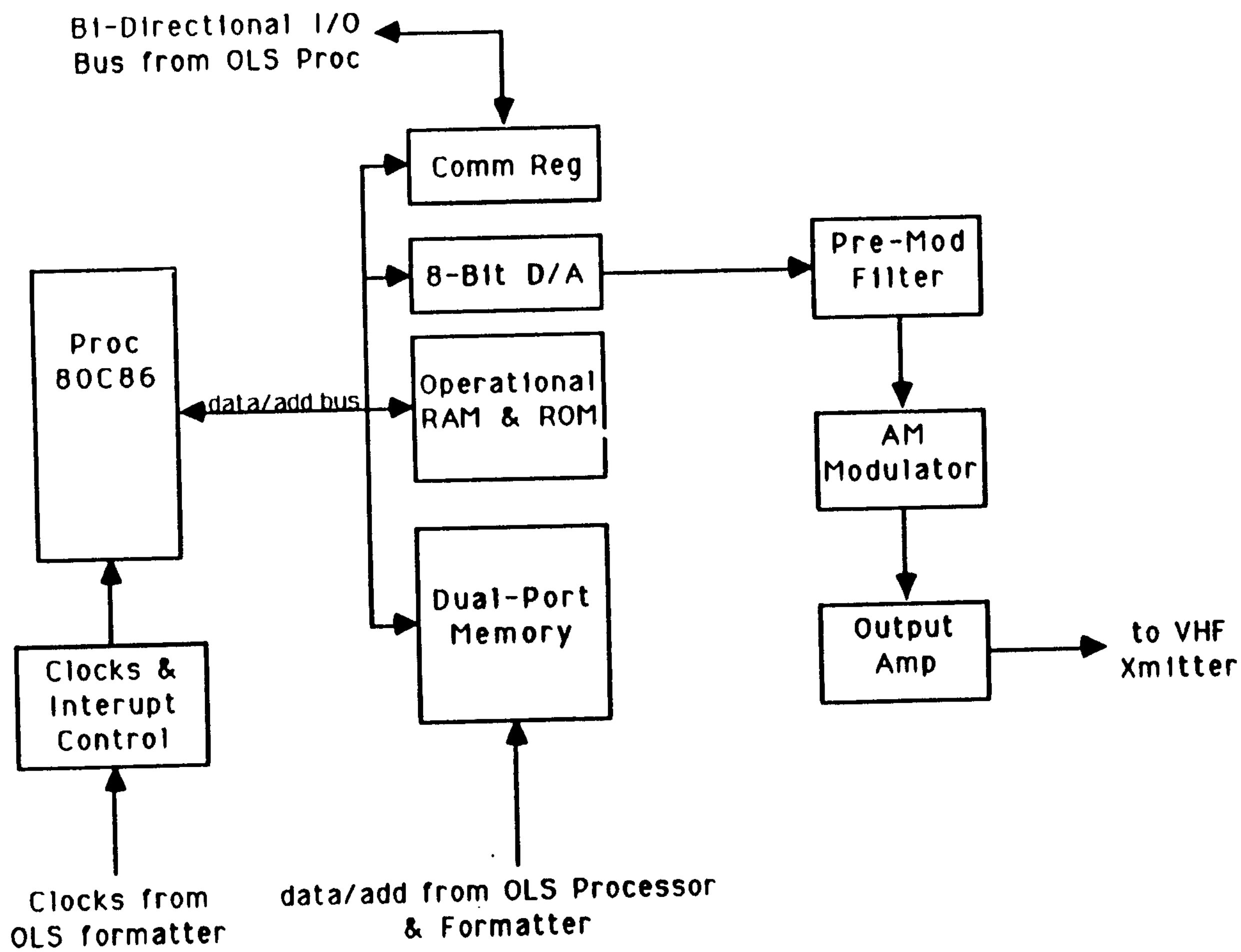
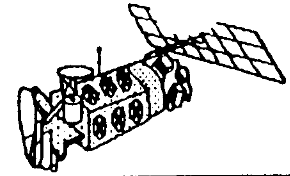
OLS APT FORMATTER

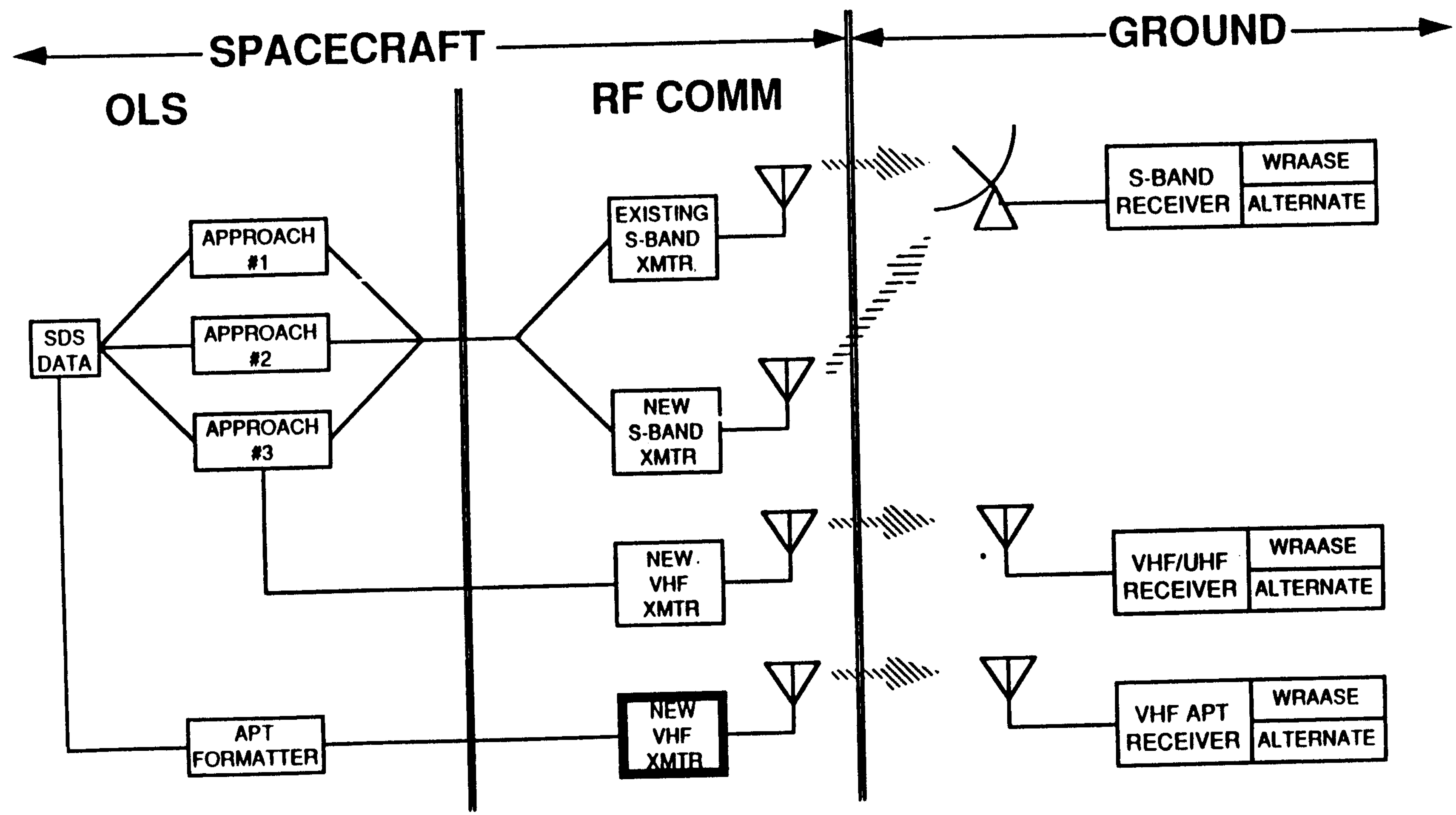


SPACECRAFT RF COMMUNICATIONS - APT

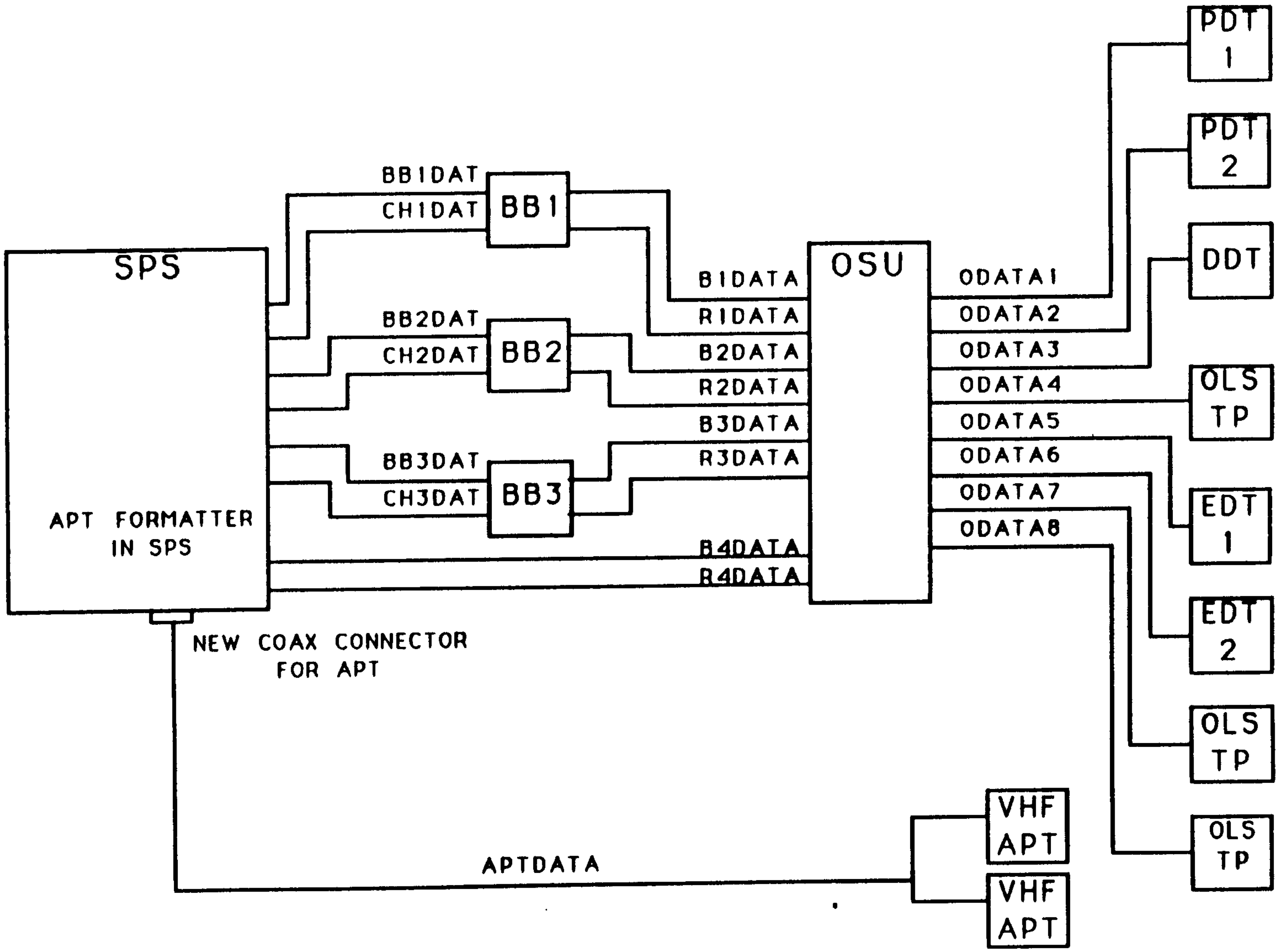


- Route APT data to dedicated VHF transmitter and antenna units
- Transmitter, antenna and RF switch designs will be based on TIROS design
- Design modifications to spacecraft bus almost the same as digital VHF and S-Band approaches; OLS modifications are extensive

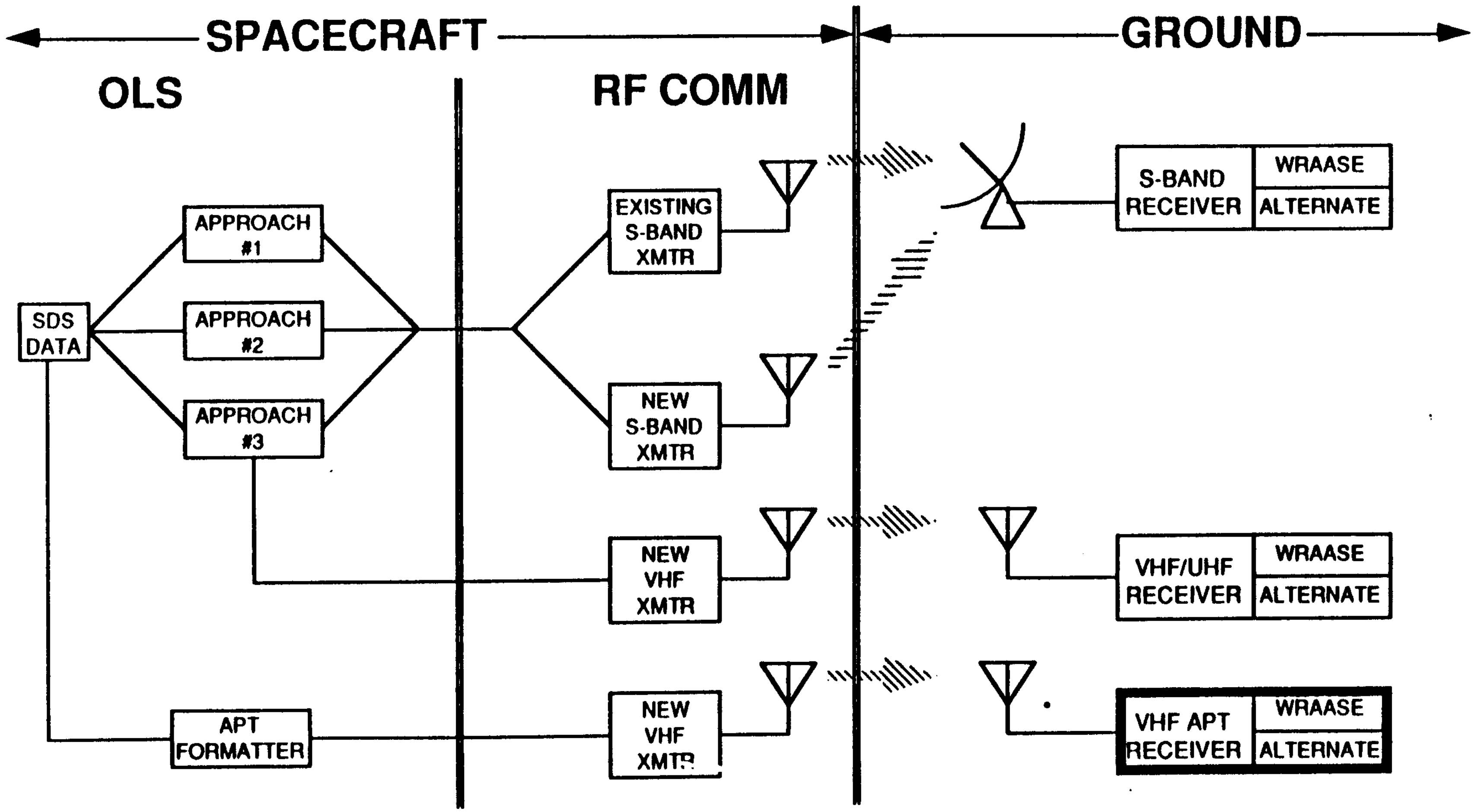
RF COMMUNICATIONS APT



APT TRANSMITTER CONNECTION



GROUND - APT


SPACECRAFT
GROUND
OLS
RF COMM
SDS DATA
APPROACH #1
APPROACH #2
APPROACH #3
APT FORMATTER
EXISTING S-BAND XMTR
NEW S-BAND XMTR
NEW VHF XMTR
NEW VHF XMTR
S-BAND RECEIVER
WRAASE
ALTERNATE
VHF/UHF RECEIVER
WRAASE
ALTERNATE
VHF APT RECEIVER
WRAASE
ALTERNATE

APT APPROACH EVALUATION CRITERIA

- SATELLITE COMPLEXITY
- RECEIVING SYSTEM COMPLEXITY
- AVAILABILITY OF MISSION SENSOR DATA
- FEASIBILITY OF ENCRYPTION
- RESOLUTION OF IMAGERY
- DIFFICULTY OF OBTAINING FREQUENCY ALLOCATION
- SUSCEPTIBILITY TO RADIO FREQUENCY INTERFERENCE (RFI)
- SUSCEPTIBILITY TO JAMMING

NOTE: THE SAME EVALUATION CRITERIA ARE USED FOR ALL APPROACHES

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GOVERNMENT INFORMATION
SYSTEMS DIVISION

COMPARISON OF RDS AND APT RESOLUTION

	RDS	APT
PIXELS / LINE	1465	512
LINES / IMAGE (18 MINUTE PASS)	2566	1283
ZOOM CAPABILITY:	YES	NO

NOTE: THE RESOLUTION SHOWN FOR APT IS THAT OF THE WRAASE RECEIVER WHEN SET UP FOR APT RECEPTION

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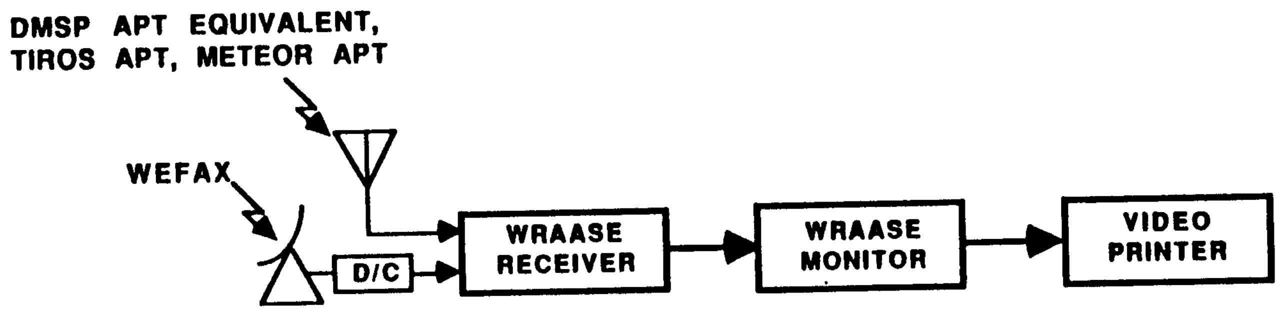
APPROACHES FOR APT RECEPTION

WRAASE APPROACH



•NO PROVISIONS ARE MADE FOR POINTING THE WEFAX ANTENNA ABOARD SHIP

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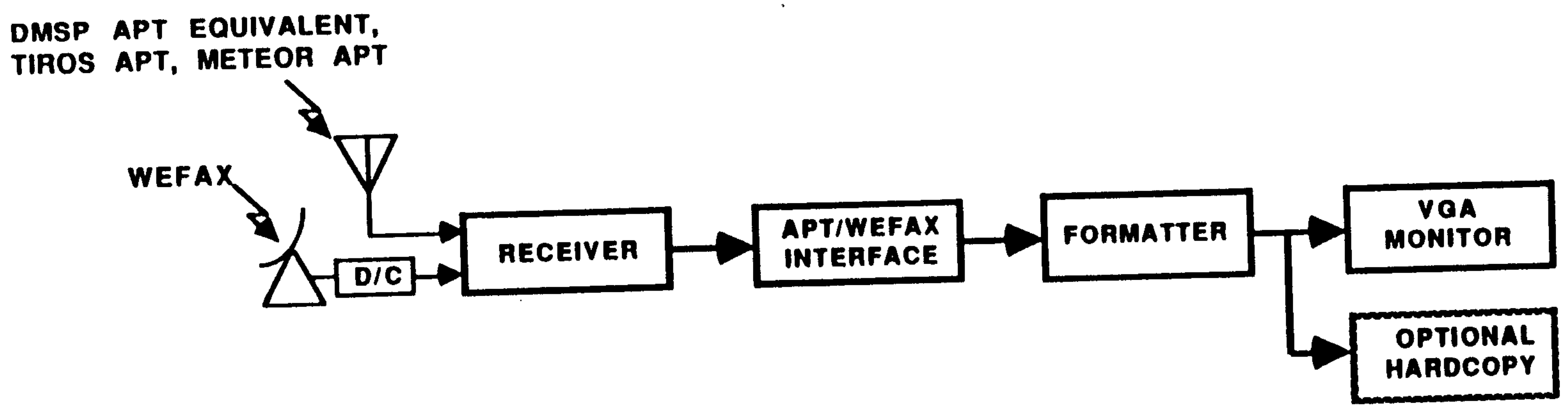
SYSTEMS DIVISION

APPROACHES FOR APT RECEPTION

ALTERNATE APPROACH



•NO PROVISIONS ARE MADE FOR POINTING THE WEFAX ANTENNA ABOARD SHIP

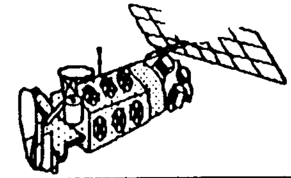
PROS AND CONS OF APT APPROACH

ADVANTAGES:

- WRAASE EQUIPMENT CAN BE USED AS-IS

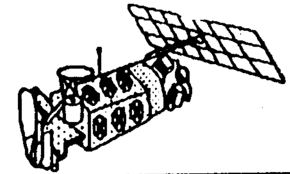
DISADVANTAGES:

- MOST EXTENSIVE SATELLITE MODIFICATIONS OF ALL THREE APPROACHES
  - -GREATEST SATELLITE COMPLEXITY
  - -LATEST IMPLEMENTATION DATE
- NO MISSION SENSOR DATA
- NO ENCRYPTION
- REDUCED RESOLUTION
- OMNI ANTENNA IS MORE SUSCEPTIBLE TO RFI AND JAMMING THAN DIRECTIONAL ANTENNA USED IN S-BAND APPROACH



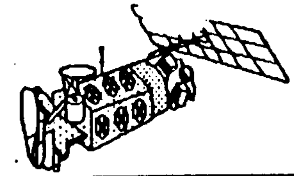
SPACE SEGMENT QUALIFICATION AND TEST PLANS

OLS QUALIFICATION AND TEST PLANS



- DIGITAL APPROACH #1 WOULD BE TESTED AND QUALIFIED AT SPACECRAFT LEVEL
- DIGITAL APPROACH #2
  - OSU REWORK TESTED AT BOARD AND BOX LEVEL
    - 8 TEMPERATURE CYCLES
  - OSU VIBRATED AT ACCEPTANCE LEVELS
  - OSU RETESTED AT SUBSYSTEM LEVEL USING BTM
    - 1 ADDITIONAL TEMPERATURE CYCLE
- DIGITAL APPROACH #3
  - SAME AS DIGITAL APPROACH #2 WITH THE ADDITION OF THE SPS (SAME RETEST AND VIBRATION)
- APT APPROACH TEST CYCLE SAME AS DIGITAL APPROACH #2

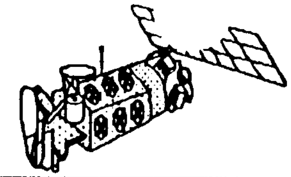
SPACECRAFT QUALIFICATION PLANS



- Only the VHF/UHF transmitter and VHF/UHF antenna units will require qualification

- Qualification will be performed per the contractually tailored requirements of MIL-STD-1540B

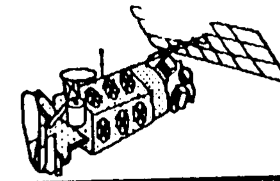
TEST PLAN
SYSTEM LEVEL



- For existing S-Band approaches, no additional test or special retest required for any spacecraft RF communications units

- System-level "OLSSIMFLT" test will be modified to exercise the RDS link

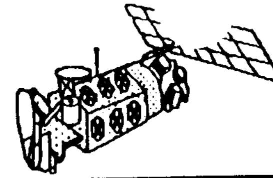
TEST PLAN



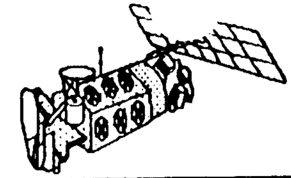
- Additional units:
  - S-Band Transmitters
  - VHF/UHF Transmitters (new)
  - RF switches (new)
  - Encryption Unit (GFE)
  - Stationary S-Band Antenna
  - Deployable VHF/UHF Antenna (new)

- Modified Units:
  - Programmable Information Processor
  - Controls Interface Unit
  - OLS
  - Harness

TEST PLAN

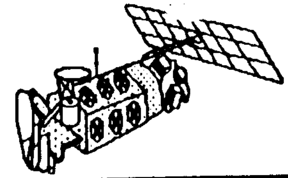


- S-Band transmitters and antenna will be acceptance tested in accordance with approved guidelines described in their respective test procedures.
- VHF/UHF transmitters and antenna qualification units will be constructed and tested in accordance with contractually tailored requirements of MIL-STD-1540B
- RF switches, which will be purchased from a vendor, will be tested by the vendor in accordance with contractually tailored requirements of MIL-STD-1540B
- Modified units will not be requalified, but design verification test will be performed
- Acceptance testing will be conducted on all flight hardware in accordance with contractually tailored requirements of MIL-STD-1540B prior to integration on the spacecraft
- System-level tests will be modified to exercise all new functions



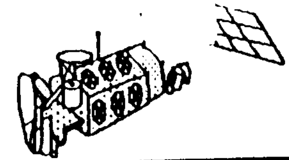
TRADEOFF MATRIX

TRADEOFF MATRIX



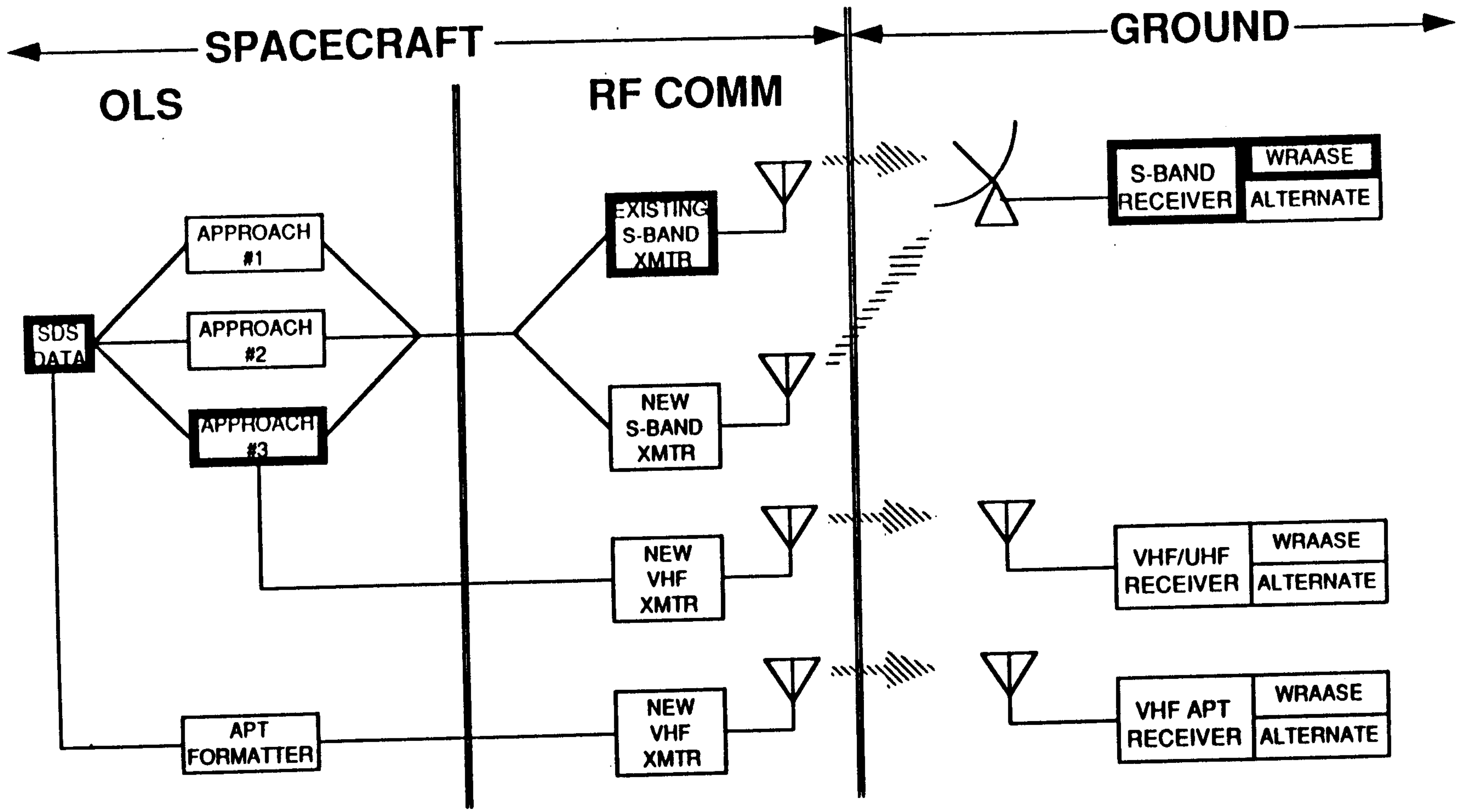
	S-BAND DIGITAL		VHF/UHF DIGITAL	VHF ANALOG (APT)
SPACE SEGMENT	EXISTING S-BAND XMTRS	NEW S-BAND XMTRS		
HARDWARE REQUIREMENTS				
• NEW UNITS	ENCRYPTER	XMTRS; ANTENNA; ENCRYPTERS	XMTRS; ANTENNA; ENCRYPTERS	XMTRS; ANTENNA
- POWER CONSUMPTION	10 W	38 W	31.2 W	22.1 W
- SIZE/WEIGHT	3.7 LBS	9.9 LBS	11 LBS	9.6 LBS
• MODIFIED UNITS	SWH, OSU*, SPS**	SWH, OSU, SPS	HARNESS; CIU; SPS; OSU	HARNESS; CIU; SPS
ENCRYPTION	FEASIBLE	FEASIBLE	FEASIBLE	NOT FEASIBLE
MISSION SENSOR DATA	AVAILABLE	AVAILABLE	AVAILABLE	NOT AVAILABLE
FREQUENCY ALLOCATION	NOT DIFFICULT	NOT DIFFICULT	DIFFICULT	DIFFICULT
COST	LOW	LOW	MODERATE	EXPENSIVE
SCHEDULE	S11 AND UP	S15 AND UP	S16 AND UP	S16 AND UP
GROUND SEGMENT				
ANTENNA COMPLEXITY	MODERATE, STEERABLE		SIMPLE, OMNIDIRECTIONAL	SIMPLE, OMNIDIRECTIONAL
PERFORMANCE				
• GRIDDING	DERIVED FROMTRANSMITTED EPHEMERIS		DERIVED FROM TRANSMITTED EPHEMERIS	EMBEDDED IN IMAGE
• RESOLUTION	SAME AS SDS		SAME AS SDS	SAME AS TIROS APT
EASE OF USE	MODERATE		SIMPLE	SIMPLE
COST	MODERATE		MODERATE	LOW

* APPROACHES #2 AND #3 ONLY ** APPROACH #3 ONLY

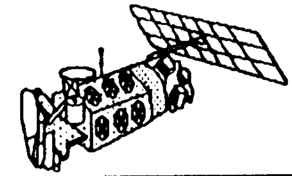


SUMMARY AND RECOMMENDATIONS

RECOMMENDED DEMONSTRATION APPROACH



SUMMARY AND RECOMMENDATIONS
OLS CONSIDERATIONS



- THE QUICKEST ROUTE TO A DEMONSTRATION SYSTEM IS DIGITAL APPROACH #1 - SEVERAL DISADVANTAGES
  - DATA AVAILABLE ONLY FROM FORMATTER-G
  - DATA IS NRZ-L, COMPLICATING GROUND SEGMENT
- DIGITAL APPROACH #2 IS BETTER THAN #1 BUT STILL LIMITED BECAUSE DATA IS AVAILABLE ONLY FROM FORMATTER-G
- APPROACH #3 IS MOST DESIRABLE FOR BOTH DEMONSTRATION AND OPERATIONAL SYSTEMS
  - BEST APPROACH FOR GROUND SEGMENT
  - MORE COMPLETE REDUNDANCY
  - OLS IMPACT ONLY SLIGHTLY HIGHER THAN APPROACH #2
- IF TIME CONSTRAINTS DO NOT PERMIT IMPLEMENTATION OF APPROACH #2 OR #3, APPROACH #1 IS SATISFACTORY
- APT APPROACH NOT RECOMMENDED BECAUSE OF COMPLEXITY, LACK OF ENCRYPTION AND NO MISSION SENSOR DATA

HARRIS
GOVERNMENT INFORMATION
SYSTEMS DIVISION

RECEIVING TERMINAL RECOMMENDATIONS FOR THE LONG TERM (OPERATIONAL PHASE)

- **DEVELOP LANDBASED AND SHIPBOARD OPERATIONAL RDS RECEIVING SYSTEMS:**

BASELINE APPROACH:

-DIGITAL RDS AT S-BAND (NEW FREQ), BPSK MODULATION, CONVOLUTIONAL CODING (R=1/2, K=7)

ANTENNA:

-SYSTEMS BUILT DURING EVALUATION PHASE RETAIN SAME ANTENNA AND POSITIONER

-USE EXPERIMENTAL DATA OBTAINED DURING EVALUATION PHASE TO DETERMINE MINIMUM ANTENNA SIZE FEASIBLE FOR OPERATIONAL SYSTEM

RDS FORMATTER AND MONITOR:

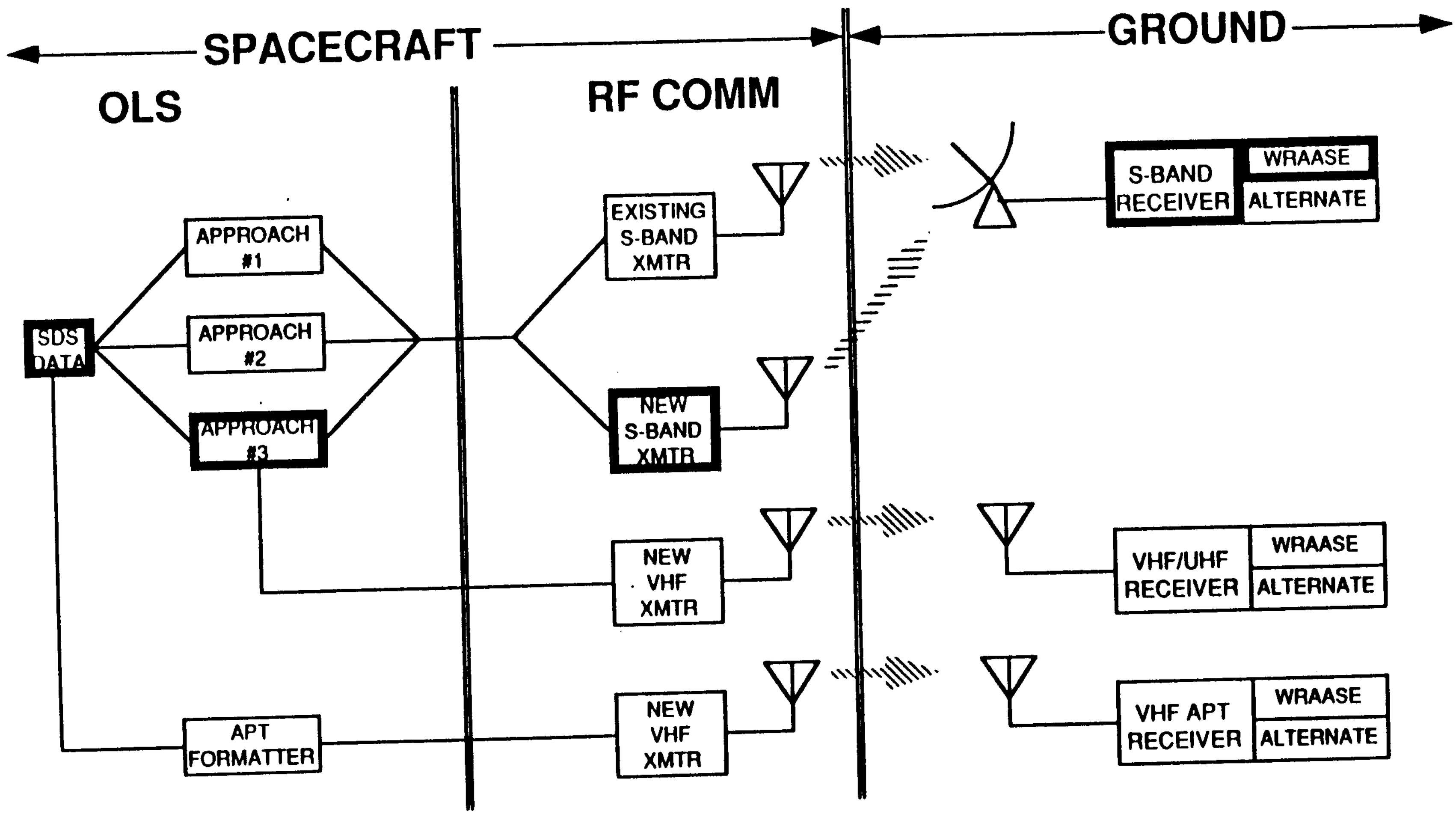
-RETAIN FORMATTER AND MONITOR

-ACTIVATE VITERBI ERROR CORRECTION DECODER

CRYPTO:

-USE SAM-KG (GFE)

RECOMMENDED OPERATIONAL APPROACH



RECEIVING TERMINAL RECOMMENDATIONS FOR THE NEAR TERM (EVALUATION PHASE)

- **DEVELOP LANDBASED AND SHIPBOARD PROTOTYPE RDS RECEIVING SYSTEMS (CONT):**

RDS FORMATTER AND MONITOR:

-DEVELOP INTEGRATED DEMOD / BIT SYNC / VITERBI DECODER ON A CARD

-BYPASS VITERBI DECODER UNTIL SATELLITE WITH CONVOLUTIONAL CODING IS LAUNCHED

-DEVELOP DEINTERLEAVER / FRAME SYNC / DECOM CARD

-USE OFF-THE-SHELF TEMPEST PC/AT PROCESSOR WITH ENHANCED VGA GRAPHICS (640X480)

-USE OFF-THE-SHELF TEMPEST HIGH RESOLUTION MONITOR

-DRIVE WRAASE UNITS WITH OFF-THE-SHELF FACSIMILE OUTPUT CARD

CRYPTO:

-USE EITHER THE KG-28 OR THE NEWLY-DEVELOPED SAM-KG (CRYPTO TO BE GFE)

HARRIS
GOVERNMENT INFORMATION
SYSTEMS DIVISION

RECEIVING TERMINAL RECOMMENDATIONS FOR THE NEAR TERM (EVALUATION PHASE)

- **DEVELOP LANDBASED AND SHIPBOARD PROTOTYPE RDS RECEIVING SYSTEMS:**

BASELINE APPROACH:

-DIGITAL RDS AT S-BAND (PDT-2: 2267.5 MHz), BPSK MODULATION

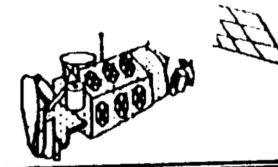
ANTENNA :

-USE 1.5-2.0 FOOT DISH ON OFF-THE-SHELF AZ-EL POSITIONER

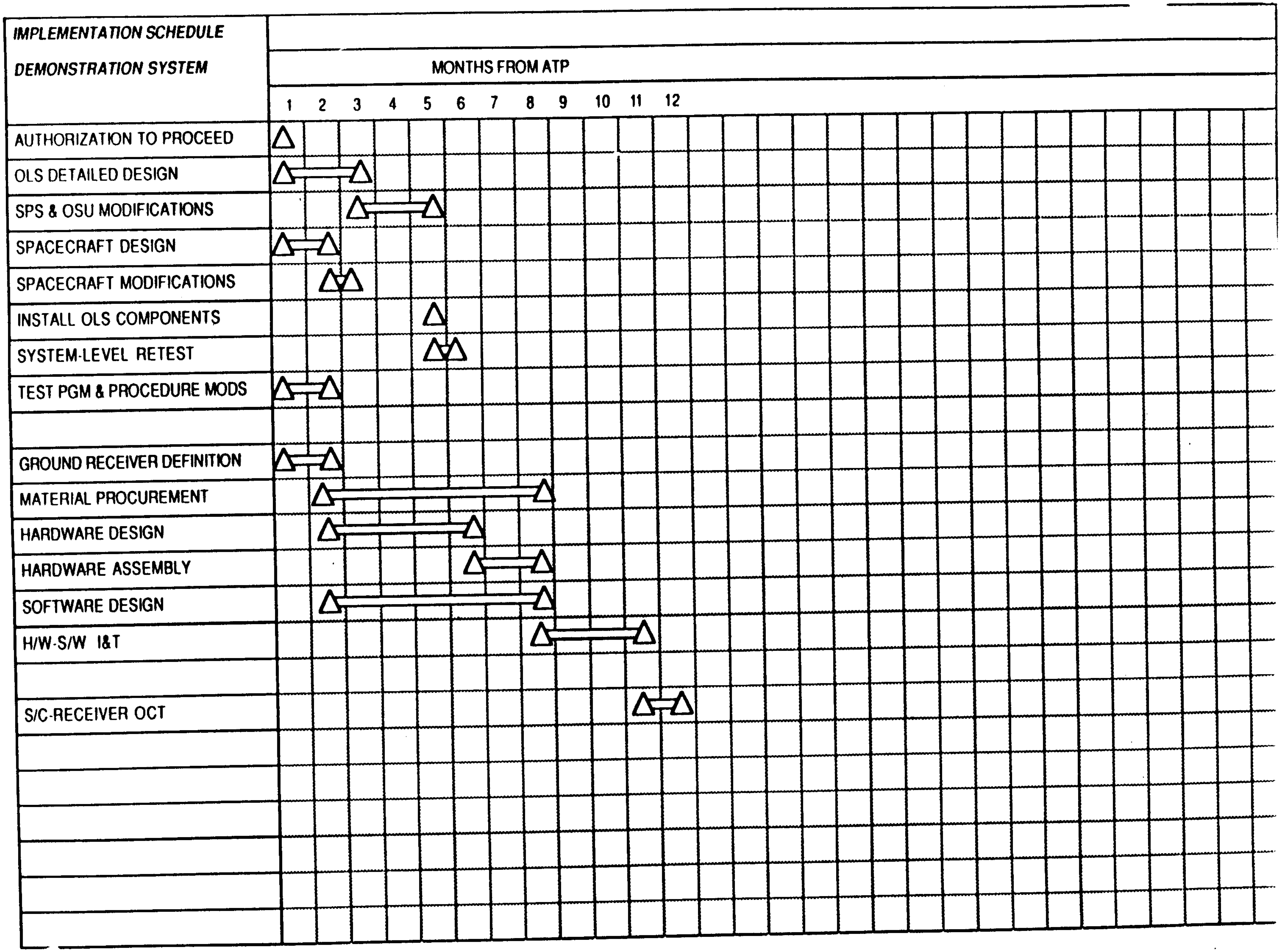
-MOUNT LANDBASED VERSION ON TRIPOD FOR FIELD DEPLOYMENT

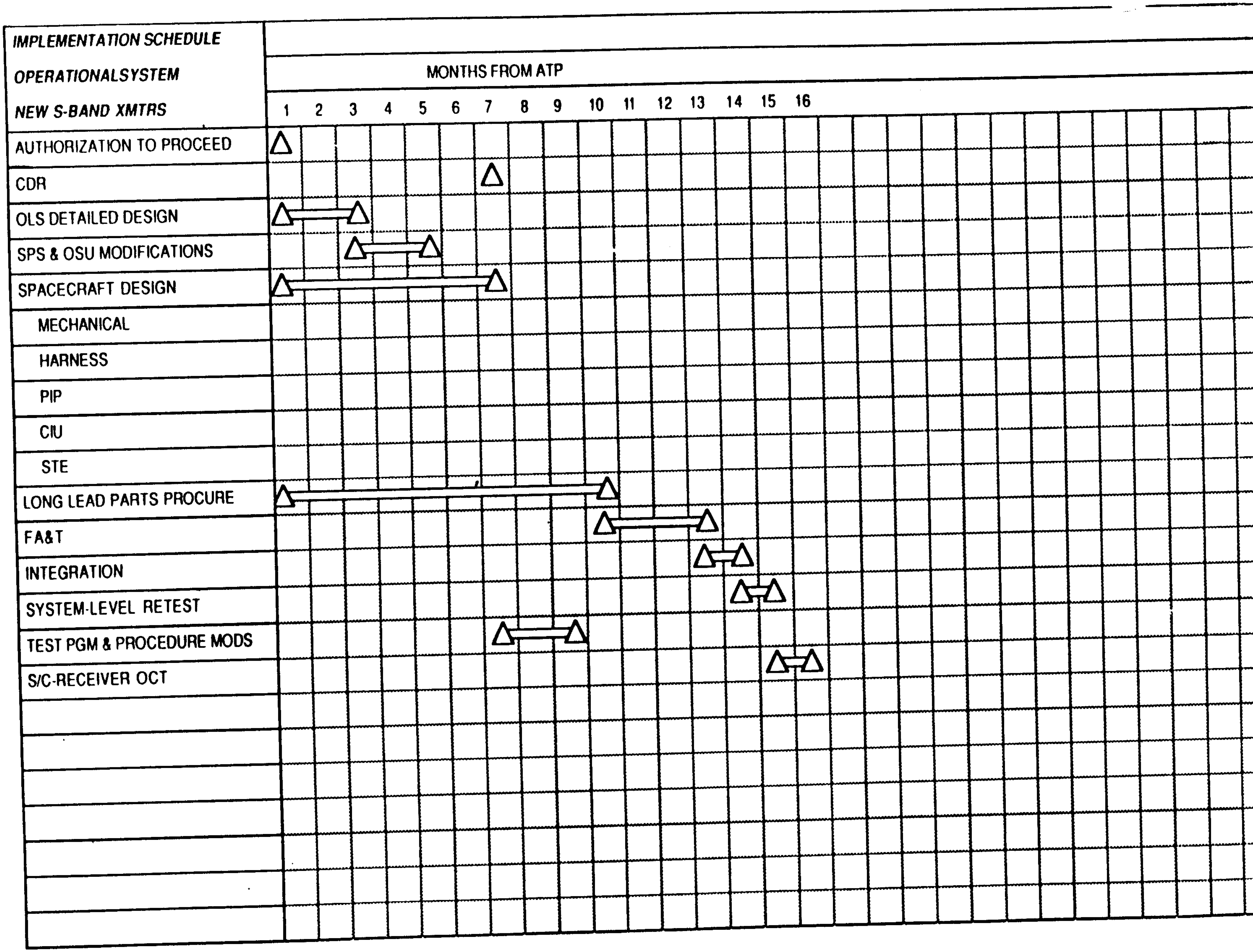
-MOUNT SHIPBOARD VERSION ON PITCH-AND-ROLL-STABILIZED PLATFORM

-INTERFACE SHIPBOARD VERSION WITH SHIP'S INERTIAL NAVIGATION SYSTEM



SYSTEM IMPLEMENTATION SCHEDULE

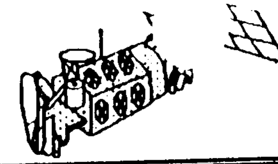

IMPLEMENTATION SCHEDULE
DEMONSTRATION SYSTEM
MONTHS FROM ATP
1 2 3 4 5 6 7 8 9 10 11 12
AUTHORIZATION TO PROCEED
OLS DETAILED DESIGN
SPS & OSU MODIFICATIONS
SPACECRAFT DESIGN
SPACECRAFT MODIFICATIONS
INSTALL OLS COMPONENTS
SYSTEM-LEVEL RETEST
TEST PGM & PROCEDURE MODS
GROUND RECEIVER DEFINITION
MATERIAL PROCUREMENT
HARDWARE DESIGN
HARDWARE ASSEMBLY
SOFTWARE DESIGN
H/W-S/W I&T
S/C-RECEIVER OCT


IMPLEMENTATION SCHEDULE
OPERATIONALSYSTEM
NEW S-BAND XMTRS
MONTHS FROM ATP
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
AUTHORIZATION TO PROCEED
CDR
OLS DETAILED DESIGN
SPS & OSU MODIFICATIONS
SPACECRAFT DESIGN
MECHANICAL
HARNESS
PIP
CIU
STE
LONG LEAD PARTS PROCURE
FA&T
INTEGRATION
SYSTEM-LEVEL RETEST
TEST PGM & PROCEDURE MODS
S/C-RECEIVER OCT

HARRIS
GOVERNMENT INFORMATION
SYSTEMS DIVISION

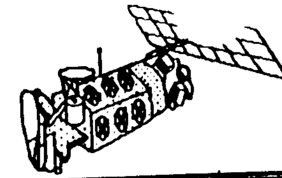
RECEIVING TERMINAL SCHEDULE

- **S-BAND DEMO SYSTEM**
  - 10 MONTHS TO DEMO
- **S-BAND AND VHF APPROACHES WITH OR WITHOUT WRAASE**
  - 12 MONTHS DEVELOPMENT
  - 8 MONTHS PRODUCTION
- **APT APPROACH WITHOUT WRAASE**
  - NO DEVELOPMENT
  - 6 MONTHS PRODUCTION

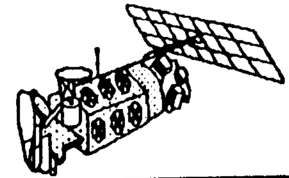


REMAINING TASKS

REMAINING TASKS



- Generation of a joint Technical Operating Report (TOR)
  - CDRL requires delivery of the TOR NLT 45 days after the completion of the study



RECOMMENDATIONS FOR CONTINUING THE RDS EFFORT

RECOMMENDATIONS FOR CONTINUING THE RDS EFFORT

- Government and contractors need to meet soon in a working session to create a detailed RDS implementation plan

- Authorization to Proceed with the demonstration system needed January 1990 to ensure that RDS is available on satellites S11 and up

APPENDIX

SAMPLE APPLICATION FORMS FOR FREQUENCY ALLOCATION

APPLICATION FOR EQUIPMENT FREQUENCY ALLOCATION

CLASSIFICATION

DATE

Form Approved OMB No. 0704-0188

Page 1 of Pages

DOD GENERAL INFORMATION

FROM

1. APPLICATION TITLE

. SYSTEM NOMENCLATURE

3. STAGE OF ALLOCATION *(X one)*

☐ a. STAGE 1 CONCEPTUAL ☐ b. STAGE 2 EXPERIMENTAL ☐ c. STAGE 3 DEVELOPMENTAL ☐ d. STAGE 4 OPERATIONAL

4. FREQUENCY REQUIREMENTS
   a. FREQUENCY(IES)
   b. EMISSION DESIGNATOR(S)

. TARGET STARTING DATE FOR SUBSEQUENT STAGES

a. STAGE 2	b. STAGE 3	c. STAGE 4

6. EXTENT OF USE

. GEOGRAPHICAL AREA FOR
   a. STAGE 2
   STAGE 3
   AGE 4

. NUMBER OF UNITS

a. STAGE 2	b. STAGE 3	c. STAGE 4

9. NUMBER OF UNITS OPERATING SIMULTANEOUSLY IN THE SAME ENVIRONMENT

10. OTHER J/F 12 APPLICATION NUMBER(S) TO BE
   ☐ a. SUPERSEDED J/F 12 /
   ☐ b. RELATED J/F 12 /

11. IS THERE ANY OPERATIONAL REQUIREMENT AS DESCRIBED IN THE INSTRUCTIONS FOR PARAGRAPH 11?
   ☐ a. YES ☐ b. NO ☐ c. NAvail

12. NAMES AND TELEPHONE NUMBERS

a. PROGRAM MANAGER	(1) COMMERCIAL	(2) AUTOVON
b. PROJECT ENGINEER	(1) COMMERCIAL	(2) AUTOVON

3. REMARKS

DOWNGRADING INSTRUCTIONS

CLASSIFICATION

INSTRUCTIONS FOR COMPLETING DD FORM 1494, "APPLICATION FOR EQUIPMENT FREQUENCY ALLOCATION"

GENERAL INFORMATION

CLASSIFICATION: This form must be classified in accordance with appropriate agency security directions. Downgrading instructions must be indicated. The highest classification for each item or sub-item as required must be indicated by a (U), (C), or (S) alongside the item or sub-item title, for classified applications.

APPLICATION PURPOSE: This is an application for development or procurement of equipment with RF emitters. It is not a frequency assignment request for operation of RF emitters. Funds must not be obligated prior to the approval of an application for frequency allocation.

DATA REQUIREMENT: All applicable data items shall be submitted for all stages. Estimated values or ranges of values may be submitted for Stage 1 and 2 in the absence of calculated or measured values and shall be annotated (EST). Values for Stages 3 and 4 should be measured.

STANDARDS: Technical parameters of the application will be evaluated against the appropriate DoD, National and International EMC standards.

REMARKS ITEMS: Use the remarks item located at the bottom of each page of the form to amplify or clarify the entries. Add continuation pages as required.

ABBREVIATIONS:

Hertz	Hz	microseconds	usec
kilohertz	kHz	decibel	dB
megahertz	MHz	dB isotropic	dBi
gigahertz	GHz	pulses per second	pps
milliwatt	mW	parts per million	ppm
watt	W	peak envelope power	PEP
nanoseconds	nsec	not applicable	NA
National Telecommunications & Information Administration	NTIA	not available	NAvail
		occupied bandwidth	OC-BW

HOW TO ASSEMBLE THE FORM:

FOR US COORDINATION:

1. DOD General Information Page
2. Transmitter Page(s)
3. Receiver Page(s)
4. Antenna Page(s)
5. Line Diagram(s)
6. Space Systems Data, if applicable
7. Continuation Page(s) (cross reference pages)
8. NTIA General Information Page

FOR FOREIGN COORDINATION: If this form is used to obtain foreign national frequency supportability comments, see the instructions on the back of the Foreign Coordination General Information Page.

DOD GENERAL INFORMATION PAGE

ITEM 1 - **Application Title.** Enter the Government nomenclature of the equipment, or the manufacturer's name and model number, and a short descriptive title.

ITEM 2 - **System Nomenclature.** Enter the nomenclature of the system for which this equipment is a subsystem, e.g., PATRIOT or Global Positioning System.

ITEM 3 - **Stage of Allocation.** Mark the appropriate block using the following NTIA definitions.

Stage 1 - Conceptual. The initial planning effort has b[illegible] completed, including proposed frequency bands and o[illegible] available characteristics.

Stage 2 - Experimental. The preliminary design has been completed, and radiation, using test equipment or preliminary models, may be required.

Stage 3 - Developmental. The major design has been completed, and radiation may be required during testing.

Stage 4 - Operational. Development has been essentially completed, and final operating constraints or restrictions required to assure compatibility need to be identified.

ITEM 4 - **Frequency Requirements.**

a. Enter the required frequency band(s). For equipment designed to operate only at a single frequency, enter this frequency. Indicate units, e.g., kHz, MHz, or GHz.

b. Enter the emission designator(s) including the necessary bandwidth for each designator, as described in Chapter 9 of the NTIA Manual e.g., 40M0PON. Identify each mode such as hopping or non-hopping, e.g. 64M0F3E (Hopping).

Enter in Item 13, "Remarks," any other information pertinent to frequency requirements, such as minimum frequency separation or special relationships involving multiple discrete frequencies.

ITEM 5 - **Target Starting Date for Subsequent Stages.** Enter proposed date of application submission for ea[illegible] subsequent stage.

ITEM 6 - **Extent of Use.** Describe extent of use that will apply Stage 4, e.g., continuous or intermittent. If intermittent, provide information including the expected number of hours of operation per day or other appropriate time period; scheduling capability; and any conditions governing the times of intermittent use, e.g., used only during terminal guidance phase, used only as required for calibration of test range equipment.

ITEM 7 - **Geographical Area.** Enter geographical location(s) or area(s) of use for this and subsequent stage(s), e.g., Gilfillan Plant, Los Angeles, California, and White Sands Missile Range, New Mexico (Stage 2); US&P (Stage 3); US&P, NATO Countries and Korea (Stage 4). Provide geographical coordinates (degrees, minutes, seconds) if available.

ITEM 8 - **Number of Units.** Enter total number of units planned for the stage review requested and the subsequent stages.

ITEM 9 - **Number of Units Operating Simultaneously in the Same Environment.** Enter maximum number of these units planned to be operating simultaneously in the same environment during Stage 4 use.

ITEM 10 - **Other J/F 12 Application Number(s).** Mark appropriate block(s) and enter J/F 12 number(s) for superseded and/or related application(s).

ITEM 11 - **Operational Requirement.** If this equipment will operate with the same or similar equipment used by other [illegible] Military Services, DoD Components, US Governm[illegible] Agencies or Allied Nations, mark "Yes," and specify in [illegible] 13, "Remarks," the Services, Agencies or countries include the country's services).

ITEMS 12 AND 13 - Self-explanatory.

CLASSIFICATION | PAGE

TRANSMITTER EQUIPMENT CHARACTERISTICS

1. NOMENCLATURE, MANUFACTURER'S MODEL NO.

2. MANUFACTURER'S NAME

3. TRANSMITTER INSTALLATION

4. TRANSMITTER TYPE

5. TUNING RANGE

6. METHOD OF TUNING

7. RF CHANNELING CAPABILITY

8. EMISSION DESIGNATOR(S)

9. FREQUENCY TOLERANCE

10. FILTER EMPLOYED *(x one)*

☐ a. YES ☐ b. NO

11. SPREAD SPECTRUM *(x one)*

☐ a. YES ☐ b. NO

12. EMISSION BANDWIDTH *(x and complete as applicable)*

☐ CALCULATED ☐ MEASURED

a. -3 dB

b. -20 dB

c. -40 dB

d. -60 dB

e. OC-BW

13. MAXIMUM BIT RATE

14. MODULATION TECHNIQUES AND CODING

15. MAXIMUM MODULATION FREQUENCY

16. PRE-EMPHASIS *(x one)*

☐ a. YES ☐ b. NO

17. DEVIATION RATIO

18. PULSE CHARACTERISTICS

a. RATE

b. WIDTH

c. RISE TIME

d. FALL TIME

e. COMP RATIO

19. POWER

a. MEAN

b. PEP

20. OUTPUT DEVICE

21. HARMONIC LEVEL

a. 2nd

b. 3rd

c. OTHER

22. SPURIOUS LEVEL

23. FCC TYPE ACCEPTANCE NO.

24. REMARKS

CLASSIFICATION

INSTRUCTIONS FOR COMPLETING DD FORM 1494, "APPLICATION FOR EQUIPMENT FREQUENCY ALLOCATION" TRANSMITTER EQUIPMENT CHARACTERISTICS PAGE

ITEM 1 - **Nomenclature, Manufacturer's Model No.** Enter the Government assigned alphanumeric equipment designation. If above is not available, enter the manufacturer's model number, e.g., MIT 502, and complete Item 2. If above is not available, enter a short descriptive title, e.g., ATS-6 telemetry transmitter.

ITEM 2 - **Manufacturer's Name.** Enter the manufacturer's name if available. If a manufacturer's model number is listed in Item 1, this item must be completed.

ITEM 3 - **Transmitter Installation.** List specific type(s) of vehicle(s), ship(s), plane(s) or building(s), etc., where the transmitter(s) will be installed.

ITEM 4 - **Transmitter Type.** Enter the generic class of the transmitter, e.g., Frequency Scan, Scan While Track Radar, Monopulse Tracker, AM or FM Communications.

ITEM 5 - **Tuning Range.** Enter the frequency range through which the transmitter is capable of being tuned, e.g., 225-400 MHz. For equipment designed to operate only at a single frequency, enter this frequency. Indicate units, e.g., kHz, MHz or GHz.

ITEM 6 - **Method of Tuning.** Enter the method of tuning, e.g., crystal, synthesizer or cavity. If the equipment is not readily tunable in the field, indicate in Item 24, "Remarks," the complexity of tuning. Include complexity factors such as skill levels involved, major assemblies involved, time required, and location (factory or depot) where equipment is to be tuned.

ITEM 7 - **RF Channeling Capability.** Describe the RF channeling capability. For uniformly spaced channels, enter the center frequency of the first channel and channel spacing e.g., first channel 406 MHz, 100 kHz increments; for continuous tuning, enter the lowest frequency and the word "continuous;" for others, such as SSB or cases where channel selection is under software control, enter a detailed description in Item 24, "Remarks." Any constraints on using any of these channels must be described in Item 24, "Remarks," e.g., degraded channels, internal hardwiring limitations or lockout capability for frequency hopping systems.

ITEM 8 - **Emission Designator(s).** Enter the emission designator(s) including the necessary bandwidth for each designator as described in Chapter 9 of the NTIA Manual, e.g., 16K0F3E. For systems with a frequency hopping mode as well as a non-hopping mode enter the emission designators for each mode. Identify each mode such as hopping or non-hopping.

ITEM 9 - **Frequency Tolerance.** Enter the frequency tolerance, i.e., the maximum departure of a transmitter from its assigned frequency after normal warm-up time has been allowed. Indicate the units in parts per million (ppm) for all emission types except single sideband which shall be indicated in Hertz (Hz).

ITEM 10 - **Filter Employed.** Mark the appropriate block. Provide the characteristics of any filter used in Item 24, "Remarks."

ITEM 11 - **Spread Spectrum.** Mark the appropriate block. If "Yes," see instructions for Item 14

ITEM 12 - **Emission Bandwidth.** Enter the emission bandwidths for which the transmitter is designed at the -3, -20, and -60 dB levels and the occupied bandwidth. The bandwidth at -40 dB shall also be entered for pulse radar transmitters. The emission bandwidth is defined as that appearing at the antenna terminals and includes any significant attenuation contributed by filtering in the output circuit or transmission lines. Values of emission bandwidth specified should be indicated as calculated or measured by marking the appropriate block. Indicate units used, e.g., Hz, kHz or MHz. Note that the Occupied Bandwidth (Item 12(e)) is defined as the frequency bandwidth such that, below lower and above its upper frequency limits, the m powers radiated are each equal to 0.5% of the total m power radiated.

ITEM 13 - **Maximum Bit Rate.** Enter the maximum information bit rate for digital equipment, in bits per second. If spread spectrum is used, enter the bit rate after encoding.

ITEM 14 - **Modulation Techniques and Coding.** Describe in detail the modulation and/or coding techniques employed. For complex modulation schemes such as direct sequence spread spectrum, frequency hopping, frequency agile, etc., enter full details in Item 24, "Remarks."

ITEM 15 - **Maximum Modulation Frequency.** For frequency or phase modulated transmitter enter the maximum modulation or baseband frequency. This frequency is assumed to be the frequency at -3 dB point on the high frequency side of the modulator response curve. Indicate the units, e.g., Hz, kHz or MHz.

ITEM 16 - **Pre-emphasis.** For frequency or phase modulated transmitters mark the appropriate block to indicate whether pre-emphasis is available.

ITEM 17 - **Deviation Ratio.** For frequency or phase modulated transmitter enter the deviation ratio computed with the formula:

$$\text{Deviation Ratio} = \frac{\text{Maximum Frequency Deviation}}{\text{Maximum Modulation Frequency}}$$

ITEM 18 - **Pulse Characteristics.** For pulse modulated transmitters

a. Enter the pulse repetition rate in pulses per sec (pps).

b. Enter the pulse width at the half voltage levels in microseconds (usec).

c. Enter the pulse rise time in microseconds (usec). This is the time duration for the leading edge of the voltage pulse to rise from 10% to 90% of its peak amplitude.

d. Enter the pulse fall time in microseconds (usec). This is the time duration for the trailing edge of the voltage pulse to fall from 90% to 10% of its peak amplitude.

e. Enter the maximum pulse compression ratio, if applicable.

ITEM 19 - **Power.** Enter the mean power delivered to the antenna terminals for all AM and FM emissions, or the peak envelope power (PEP) for all other classes of emissions. If there are any unique situations such as interrupted CW, provide details in Item 24, "Remarks." Indicate the units, e.g., W or kW.

ITEM 20 - **Output Device.** Enter a description of the device used in the transmitter output stage, e.g., ceramic diode, reflex klystron, transistor or TWT.

ITEM 21 - **Harmonic Level.** Enter the harmonic level in dB relative to the fundamental of the 2nd and 3rd harmonics. Enter in Item c. the relative level in dB of the highest powered harmonic above the 3rd.

ITEM 22 - **Spurious Level.** Enter the maximum value of spur emission in dB relative to the fundamental which o outside the -60 dB point on the transmitter fundam emission spectrum (Item 12) and does not occur o harmonic of the fundamental frequency

ITEM 23 - **FCC Type Acceptance No.** Enter the FCC type acceptance number if applicable

RECEIVER EQUIPMENT CHARACTERISTICS

1. NOMENCLATURE, MANUFACTURER'S MODEL NO.

2. MANUFACTURER'S NAME

3. RECEIVER INSTALLATION

4. RECEIVER TYPE

5. TUNING RANGE

6. METHOD OF TUNING

7. RF CHANNELING CAPABILITY

8. EMISSION DESIGNATOR(S)

9. FREQUENCY TOLERANCE

10. IF SELECTIVITY	1st	2nd	3rd
a. -3 dB			
b. -20 dB			
c. -60 dB			

11. RF SELECTIVITY *(X and complete as applicable)*

☐ CALCULATED ☐ MEASURED

a. -3 dB

b. -20 dB

c. -60 dB

d. Preselection Type

12. IF FREQUENCY

a. 1st

b. 2nd

c. 3rd

13. MAXIMUM POST DETECTION FREQUENCY

14. MINIMUM POST DETECTION FREQUENCY

15. OSCILLATOR TUNED	1st	2nd	3rd
a. ABOVE TUNED FREQUENCY			
b. BELOW TUNED FREQUENCY			
c. EITHER ABOVE OR BELOW THE FREQUENCY			

16. MAXIMUM BIT RATE

17. SENSITIVITY

a. SENSITIVITY dBm

b. CRITERIA

c. NOISE FIG dB

d. NOISE TEMP Kelvin

18. DE-EMPHASIS *(X one)*

☐ a. YES ☐ b. NO

19. IMAGE REJECTION

20. SPURIOUS REJECTION

21. REMARKS

INSTRUCTIONS FOR COMPLETING DD FORM 1494, "APPLICATION FOR EQUIPMENT FREQUENCY ALLOCATION"

RECEIVER EQUIPMENT CHARACTERISTICS PAGE

ITEM 1 - **Nomenclature, Manufacturer's Model No.** Enter the Government assigned alphanumeric equipment designation. If above is not available, enter the manufacturer's model number, e.g., MIT 502, and complete Item 2. If above is not available, enter a short descriptive title, e.g., GPS Receiver, Director Station RX.

ITEM 2 - **Manufacturer's Name.** Enter the manufacturer's name if available. If a manufacturer's model number is listed in Item 1, this item must be completed.

ITEM 3 - **Receiver Installation.** List specific type(s) of vehicle(s), ship(s), plane(s) or building(s), etc., where the receiver(s) will be installed.

ITEM 4 - **Receiver Type.** Enter the generic class, e.g., Dual Conversion Superheterodyne or Homodyne.

ITEM 5 - **Tuning Range.** Enter the frequency range through which the receiver is capable of being tuned, e.g., 225-400 MHz. For equipment designed to operate only at a single frequency, enter this frequency. Indicate units, e.g., kHz, MHz or GHz.

ITEM 6 - **Method of Tuning.** Enter the method of tuning, e.g., crystal, synthesizer or cavity. If the equipment is not readily tunable in the field, indicate in Item 21, "Remarks," the complexity of tuning. Include complexity factors such as skill levels involved, major assemblies involved, time required, and location (factory or depot) where equipment is to be tuned.

ITEM 7 - **RF Channeling Capability.** Describe the RF channeling capability. For uniformly spaced channels, enter the center frequency of the first channel and channel spacing e.g., first channel 406 MHz, 100 kHz increments; for continuous tuning, enter the lowest frequency and the word "continuous;" for others, including cases where channel selection is under software control, enter a detailed description in Item 21, "Remarks."

ITEM 8 - **Emission Designator(s).** Enter the emission designator(s) including the necessary bandwidth(s), for each designator, e.g., 16K0F3E. For systems with a frequency hopping mode as well as a non-hopping mode enter the emission designators for each mode.

ITEM 9 - **Frequency Tolerance.** Enter the frequency tolerance, i.e., the maximum departure of a receiver from its assigned frequency after normal warm-up time has been allowed. Indicate the units in parts per million (ppm) for all emission types except single sideband which shall be indicated in Hertz (Hz).

ITEM 10 - **IF Selectivity.** Enter the bandwidth for each IF stage at the -3, -20 and -60 dB levels. Indicate units, e.g., kHz or MHz.

ITEM 11 - **RF Selectivity.** Enter the bandwidth at the -3, -20 and -60 dB levels. The RF bandwidth includes any significant attenuation contributed by filtering in the input circuit or transmission line. Values of RF bandwidths specified should be indicated as calculated or measured by marking the appropriate block. Indicate units, e.g., kHz or MHz. Enter the preselection type, e.g., tunable cavity.

ITEM 12 - **IF Frequency.** Enter the tuned frequency of the first, second and third IF stages. Indicate units, e.g., kHz or MHz.

ITEM 13 - **Maximum Post Detection Frequency.** Enter the maximum post detection frequency. This is the nominal frequency at the -3 dB point on the high frequency side of the receiver base band. Indicate units, e.g., kHz or MHz.

ITEM 14 - **Minimum Post Detection Frequency.** For multichannel FM systems enter the minimum post detection frequency. This is the nominal frequency at the -3 dB point on the low frequency side of the receiver base band. Indicate units, e.g., Hz or kHz.

ITEM 15 - **Oscillator Tuned.** Mark the appropriate block to indicate the location of the 1st, 2nd and 3rd oscillator frequencies with respect to the associated mixer input signal.

ITEM 16 - **Maximum Bit Rate.** Where applicable, enter the maximum bit rate (bps) that can be used. If spread spectrum is used, enter the bit rate after decoding. Describe any error detecting/correcting codes in Item 21, "Remarks."

ITEM 17 - **Sensitivity.**

a. Enter the sensitivity in dBm.

b. Specify criteria used, e.g., 12 dB SINAD (Signal to interference plus Noise and Distortion).

c. If the receiver is used with terrestrial systems, enter the receiver noise figure in dB.

d. If the receiver is used with space or satellite earth stations, enter the receiver noise temperature in Kelvin.

ITEM 18 - **De-emphasis.** For frequency modulated or phase modulated receivers indicate whether de-emphasis is available.

ITEM 19 - **Image Rejection.** Enter the image rejection in dB. Image rejection is the ratio of the image frequency signal level required to produce a specified output, to the desired signal level required to produce the same output.

ITEM 20 - **Spurious Rejection.** Enter the spurious rejection in dB. Enter the single level of spurious rejection that the receiver meets or exceeds at all frequencies outside the -60 dB bandwidth. Spurious rejection is the ratio of a particular out-of-band frequency signal level required to produce a specified output, to the desired signal level required to produce the same output.

ANTENNA EQUIPMENT CHARACTERISTICS

☐ a. TRANSMITTING ☐ b. RECEIVING ☐ c. TRANSMITTING AND RECEIVING

2. NOMENCLATURE, MANUFACTURER'S MODEL NO.

3. MANUFACTURER'S NAME

4. FREQUENCY RANGE

5. TYPE

6. POLARIZATION

7. SCAN CHARACTERISTICS

a. TYPE

b. VERTICAL SCAN

(1) Max Elev

(2) Min Elev

(3) Scan Rate

c. HORIZONTAL SCAN

(1) Sector Scanned

(2) Scan Rate

d. SECTOR BLANKING *(X one)* ☐ (1) Yes ☐ (2) No

8. GAIN

a. MAIN BEAM

b. 1st MAJOR SIDE LOBE

9. BEAMWIDTH

a. HORIZONTAL

b. VERTICAL

10. REMARKS

INSTRUCTIONS FOR COMPLETING DD FORM 1494, "APPLICATION FOR EQUIPMENT FREQUENCY ALLOCATION" ANTENNA EQUIPMENT CHARACTERISTICS PAGE

ITEM 1 - **Function.** Mark the appropriate block to indicate the type of function the antenna performs. For multi-antenna system use one page for each antenna.

ITEM 2 - **Nomenclature, Manufacturer's Model No.** Enter the Government assigned alpha-numeric equipment designation. If above is not available, enter the manufacturer's model number, e.g., DS6558, and complete Item 3. If above is not available, enter a short descriptive title, e.g., ATS-6 telemetry antenna.

ITEM 3 - **Manufacturer's Name.** Enter the manufacturer's name if available. If a manufacturer's model number is listed in Item 2, this item must be completed.

ITEM 4 - Frequency Range. Enter the range of frequencies for which the antenna is designed. Indicate units, e.g., kHz or MHz.

ITEM 5 - **Type.** Enter the generic name or describe general technical features, e.g., Horizontal Log Periodic, Cassegrain with Polarization Twisting, Whip, Phased Array or Conformal Array.

ITEM 6 - Polarization. Enter the polarization; if circular, indicate whether it is left or right hand.

ITEM 7 - **Scan Characteristics.**

a. If this antenna scans, enter the type of scanning, e.g., vertical, horizontal, vertical and horizontal.

b. (1) Enter the maximum elevation angle in degrees (positive or negative referenced to the horizontal) that the antenna can scan.

(2) Enter the minimum elevation angle in degrees (positive or negative referenced to the horizontal) that the antenna can scan.

(3) Enter the vertical scan rate in scans per minute.

c. (1) Enter the angular scanning range in scans per minute.

(2) Enter the horizontal scan rate scans per minute.

d. Indicate if antenna is capable of sector blanking. If yes, enter details in Item 10, "Remarks."

ITEM 8 - Gain.

a. Enter the maximum gain in dBi.

b. Enter the nominal gain of the first major side lobe of the main beam in dBi and the angular displacement from the main beam in degrees.

ITEM 9 - Beamwidth. Enter the 3 dB beamwidth in degrees.

ITEM 10 - Remarks. Use this item to describe any unusual characteristics of the antenna, particularly as they relate to th assessment of electromagnetic co patibility. Use this item to amplify clarify any of the information provided above

APPLICATION FOR SPECTRUM REVIEW

CLASSIFICATION

NTIA GENERAL INFORMATION

1. APPLICATION TITLE

2. SYSTEM NOMENCLATURE

3. STAGE OF ALLOCATION *(X one)*

☐ a. STAGE 1 CONCEPTUAL ☐ b. STAGE 2 EXPERIMENTAL ☐ c. STAGE 3 DEVELOPMENTAL ☐ d. STAGE 4 OPERATIONAL

4. FREQUENCY REQUIREMENTS
   a. FREQUENCY(IES)
   b. EMISSION DESIGNATOR(S)

5. PURPOSE OF SYSTEM, OPERATIONAL AND SYSTEM CONCEPTS (WARTIME USE) *(X one)* ☐ a. YES ☐ b. NO

6. INFORMATION TRANSFER REQUIREMENTS

7. ESTIMATED INITIAL COST OF THE SYSTEM

8. TARGET DATE FOR

a. APPLICATION APPROVAL	b. SYSTEM ACTIVATION	c. SYSTEM TERMINATION

9. SYSTEM RELATIONSHIP AND ESSENTIALITY

10. REPLACEMENT INFORMATION

11. RELATED ANALYSIS AND/OR TEST DATA

12. NUMBER OF MOBILE UNITS

13. GEOGRAPHICAL AREA FOR
   a. STAGE 2
   b. STAGE 3
   c. STAGE 4

14. LINE DIAGRAM See page(s)	15. SPACE SYSTEMS See page(s)
16. TYPE OF SERVICE(S) FOR STAGE 4	17. STATION CLASS(ES) FOR STAGE 4

18. REMARKS

DOWNGRADING INSTRUCTIONS	CLASSIFICATION	

ITEM 1 - Application Title. Enter the Government nomenclature of the equipment, or the manufacturer's name and model number, and a short descriptive title.

ITEM 2 - System Nomenclature. Enter the nomenclature of the system for which this equipment is a subsystem, e.g., PATRIOT or Global Positioning System.

ITEM 3 - Stage of Allocation. Mark appropriate block.

ITEM 4 - Frequency Requirements.

a. Enter the required frequency bands. For equipment designed to operate only at a single frequency, enter this frequency. Indicate units, e.g., kHz, MHz or GHz.

b. Enter the emission designators including the necessary bandwidth for each designator, as described in Chapter 9 of the NTIA Manual e.g., 40M0PON.

Enter in Item 18, "Remarks," any other information pertinent to frequency requirements, such as minimum frequency separation for full duplex links or repeaters; or special relationships involving multiple discrete frequencies.

ITEM 5 - Purpose of System, Operational and System Concepts. Enter a summary description of function of the system or subsystem, e.g., collect and disseminate meteorological data using satellite techniques; transmission of radar data for air traffic control; a remote control of ATC radars; provide for the transmission and reception of digital voice and data by means of LOS or tropo modes of propagation; provide navigational signal from which a broad spectrum of users are able to derive navigation data. Also include information on operational and system concepts. Mark whether the system has a wartime function.

ITEM 6 - Information Transfer Requirements. Enter the required character rate, data rates, circuit quality, reliability, etc.

ITEM 7 - Estimated Initial Cost of the System. This item is for information to show the general size and complexity of the system. It is not intended to be a determining factor in system review. For Stage 2 enter research cost, for Stage 3 enter development cost, for Stage 4 enter unit cost of equipment and expected number of equipments/systems to be procured.

ITEM 8 - Target Date. For the stage review requested, enter the appropriate date. Funds must not be obligated prior to the approval of this application. If foreign coordination is not required, then approximately one year must be allowed for application approval. If foreign coordination is required, approximately two years must be allowed for application approval.

ITEM 9 - System Relationship and Essentiality. Enter the essentiality and a statement of the relationship between the proposed system and the operational function it is intended to support.

ITEM 10 - Replacement Information. Identify existing system(s) which may be replaced by the proposed system. State any known additional frequency requirements.

ITEM 11 - Related Analysis and/or Test Data. Identify reports that can be made available documenting previous EMC studies, predictions, analyses, or prototype EMC testing that are relevant to the assessment of the system under review.

ITEM 12 - Number of Units. (For mobile systems) - Self explanatory.

ITEM 13 - Geographical Area. Enter geographic location(s) or area(s) of use for this and subsequent stage(s), e.g., Gilfillan Plant, Los Angeles, California, and White Sands Missile Range, New Mexico (Stage 2); US&P (Stage 3); US&P, NATO Countries and Korea (Stage 4). Provide geographical coordinates (degrees, minutes, seconds) if available.

ITEM 14 - Line Diagram. Enter the page number of the line diagram(s). Attach as another page the line diagram showing the links, direction of transmissions, frequency band(s), and associated equipment with J/F 12 numbers.

ITEM 15 - Space Systems. Enter the page number of the space system data. Attach as another page the space system data as described in the NTIA Manual, Paragraph 8.3.7. Data Requirement.

ITEM 16 - Type of Service(s) for Stage 4. Enter the appropriate type of service(s) that applies or will apply to the equipment in the operational stage (Stage 4), as described in Chapter 6, Table of Services, Station Classes, and Stations of the NTIA Manual. If the service is not in accordance with the allocation tables full justification must be entered.

ITEM 17 - Station Class(es) for Stage 4. Enter the appropriate station class(es) as described in Chapter 6 of the NTIA Manual.

APPLICATION FOR FOREIGN SPECTRUM SUPPORT

CLASSIFICATION

FOREIGN COORDINATION GENERAL INFORMATION

1. APPLICATION TITLE

TEM NOMENCLATURE

3. STAGE OF ALLOCATION *(X one)*

- [ ] a. STAGE 1 CONCEPTUAL
- [ ] b. STAGE 2 EXPERIMENTAL
- [ ] c. STAGE 3 DEVELOPMENTAL
- [ ] d. STAGE 4 OPERATIONAL

4. FREQUENCY REQUIREMENTS
   a. FREQUENCY(IES)
   b. EMISSION DESIGNATOR(S)

5. PROPOSED OPERATING LOCATIONS OUTSIDE US&P

6. PURPOSE OF SYSTEM, OPERATIONAL AND SYSTEM CONCEPTS

7. INFORMATION TRANSFER REQUIREMENTS

MBER OF UNITS OPERATING SIMULTANEOUSLY IN THE SAME ENVIRONMENT

9. REPLACEMENT INFORMATION

10. LINE DIAGRAM See page(s)	11. SPACE SYSTEMS See page(s)

2. PROJECTED OPERATIONAL DEPLOYMENT DATE

13. REMARKS

GRADING INSTRUCTIONS	CLASSIFICATION	

INSTRUCTIONS FOR COMPLETING DD FORM 1494, "APPLICATION FOR EQUIPMENT FREQUENCY ALLOCATION"
FOREIGN COORDINATION GENERAL INFORMATION PAGE

NOTES

1. For equipment intended to be operated outside the US&P foreign disclosure authority is required to coordinate and obtain radio frequency spectrum support from those countries where this equipment may operate. Action must be initiated to obtain foreign disclosure authority in accordance with Military Department regulations and policies for the release of appropriate data to the proposed host nations.

2. Do not complete this page unless you are preparing a foreign coordination version of the DD Form 1494. A foreign coordination version of this form is treated as a completely separate document from a US coordination version, and in general the information content will be different.

3. Frequency allocation processing for US coordination can be initiated without submitting a foreign coordination version of the DD Form 1494. In any case, submission of the US coordination version should not be delayed simply because a foreign coordination version has not been completed.

HOW TO ASSEMBLE THE APPLICATION FOR FOREIGN SPECTRUM SUPPORT:

1. Foreign Coordination General Information Page(s).
2. Transmitter Equipment Characteristics Page(s).
3. Receiver Equipment Characteristics Page(s).
4. Antenna Equipment Characteristics Page(s).
5. Continuation Page(s).

FOREIGN COORDINATION GENERAL INFORMATION PAGE

ITEM 1 - Application Title. Enter the Government nomenclature of the equipment or the manufacturer's name and model number, and a short descriptive title.

ITEM 2 - System Nomenclature. Enter the nomenclature of the system for which this equipment is a subsystem, e.g., PATRIOT or Global Positioning System.

ITEM 3 - Stage of Allocation. Mark the appropriate block.

ITEM 4 - Frequency Requirements.

a. Enter the required frequency band(s). For equipment designed to operate only at a single frequency, enter this frequency Indicate units, e.g., kHz, MHz or GHz.

b. Enter the emission designator(s) including the necessary bandwidth for each designator, as described in Chapter 9 of the NTIA Manual e.g., 40M0PON.

Enter in Item 13, "Remarks," any oth[illegible] information pertinent to freque[illegible] requirements, such as minimum frequ[illegible] separation or special relationship[illegible] between multiple discrete frequencies.

ITEM 5 - Proposed Operating Locations Outside US&P. Enter host nations, locations or areas of use. Provide geographical coordinates (degrees, minutes, seconds) if available.

ITEM 6 - Purpose of System, Operational and System Concepts. Enter a summary description of function of the system or subsystem, e.g., collect and disseminate meteorological data using satellite techniques; transmission of radar data for air traffic control; a remote control of ATC radars; provide for the transmission and reception of digital voice and data by means of LOS or tropo modes of propagation; provide navigational signal from which a broad spectrum of users are able to derive navigation data. Also include information on operational and system concepts.

ITEM 7 - Information Transfer Requirements. E[illegible] the required character rate, data ra[illegible] circuit quality, reliability, etc.

ITEM 8 - Number of Units Operating Simultaneously in the Same Environment. Enter maximum number of these units which will be operating simultaneously in the same environment, during Stage 4 use.

ITEM 9 - Replacement Information. Identify the existing equipment/system(s) and associated frequency assignments to be replaced by the proposed equipment system(s) where applicable.

ITEM 10 - Line Diagram. Enter the page number of the line diagram(s). Attach as another page the line diagram showing the links, direction of transmissions, frequency band(s), and associated equipment.

ITEM 11 - Space System. Enter the page number of the space system data. Attach as anoth[illegible] page the space system data as describ[illegible] the NTIA Manual, Paragraph 8.3.7. Requirements.

ITEM 12 - Projected Operational Deployment Date. Self explanatory.